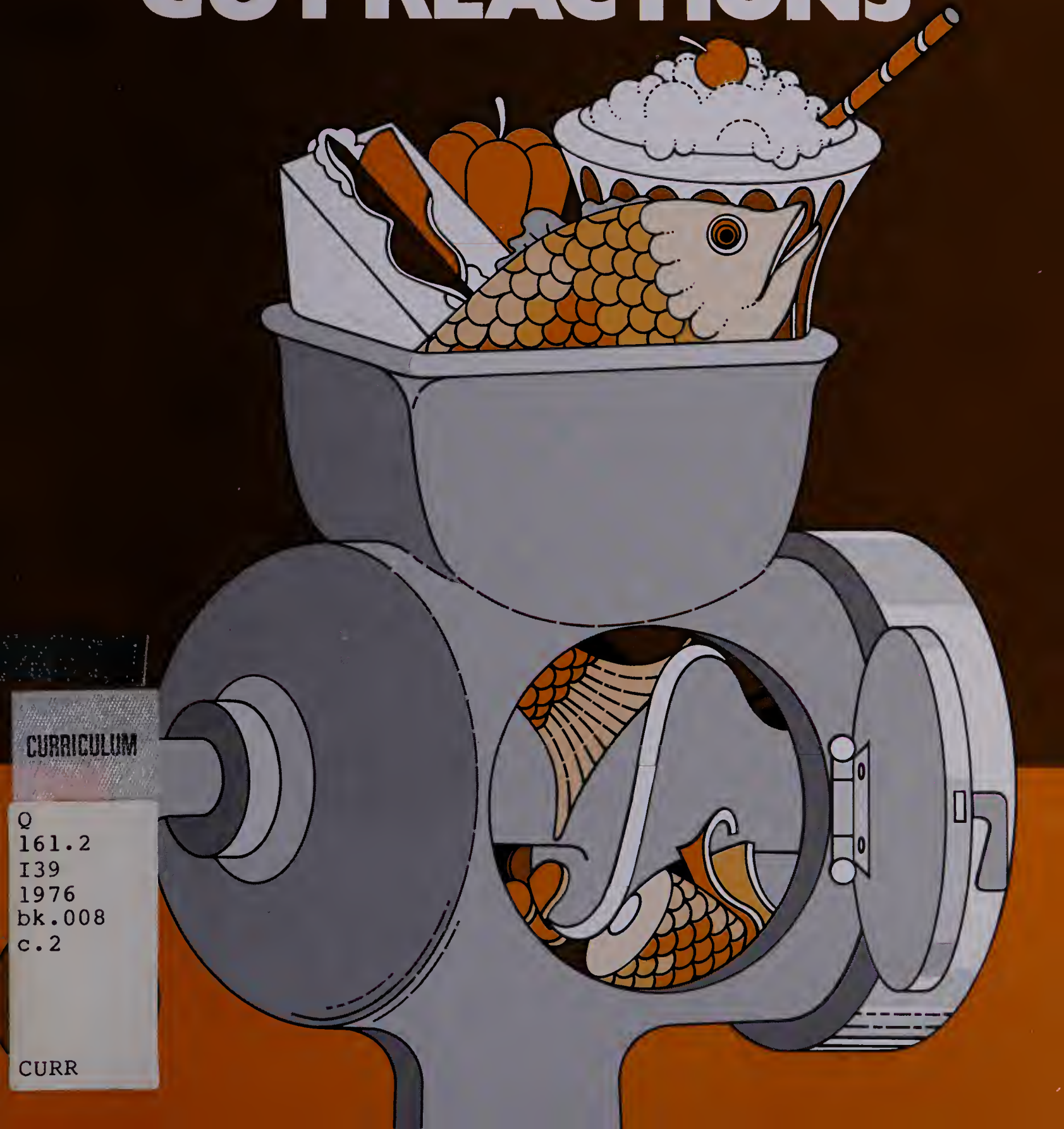
ISIS

INDIVIDUALIZED SCIENCE INSTRUCTIONAL SYSTEM

GUT REACTIONS



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1. Teachers should see that the pupil's name is clearly written in ink in the spaces above in every book issued.
2. The following terms should be used in recording the condition of the book: New; Good; Fair; Poor; Bad.

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Ginn and Company

Acknowledgments

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FOREWORD

Evidence has been mounting that something is missing from secondary science teaching. More and more, students are rejecting science courses and turning to subjects that they consider to be more practical or significant. Numerous high school science teachers have concluded that what they are now teaching is appropriate for only a limited number of their students.

As their concern has mounted, many science teachers have tried to find instructional materials that encompass more appropriate content and that allow them to work individually with students who have different needs and talents. For the most part, this search has been frustrating because presently such materials are difficult, if not impossible, to find.

The Individualized Science Instructional System (ISIS) project was organized to produce an alternative for those teachers who are dissatisfied with current secondary science textbooks. Consequently, the content of the ISIS materials is unconventional as is the individualized teaching method that is built into them. In contrast with many current science texts which aim to "cover science," ISIS has tried to be selective and to limit our coverage to the topics that we judge will be most useful to today's students.

Obviously the needs and problems of individual schools and students vary widely. To accommodate the differences, ISIS decided against producing tightly structured, pre-sequenced textbooks. Instead, we are generating short, self-contained modules that cover a wide range of topics. The modules can be clustered into many types of courses, and we hope that teachers and administrators will utilize this flexibility to tailor-make curricula that are responsive to local needs and conditions.

ISIS is a cooperative effort involving many individuals and agencies. More than 75 scientists and educators have helped to generate the materials, and hundreds of teachers and thousands of students have been involved in the project's nationwide testing program. All of the ISIS endeavors have been supported by generous grants from the National Science Foundation. We hope that ISIS users will conclude that these large investments of time, money, and effort have been worthwhile.

Ernest Burkman
ISIS Project
Tallahassee, Florida

CONTENTS

What's It All About?

Wish your stomach wouldn't rumble? Have you ever burped at the wrong time? Choked on a piece of food? Suffered from sharp internal pains? Thrown up or had diarrhea? Ever wonder if you have an ulcer?

Sounds like the start of a TV commercial, doesn't it? That's not surprising. A lot of commercials deal with cures for digestive problems. And if you answered yes to some of those questions, you have probably had some bad "gut reactions."

In this minicourse you'll find out what happens to food as it passes through your body. You'll discover how the food gets broken down, where it goes, and how it is used. You can also play a game to learn more about digestive problems.

core

Activity 1 Planning

If you can't do what is stated in Objective 1 or 2, do Activity 2 first. If you need to do Activity 6, save it for last. Any other activities you need to do may be done in any order, but don't forget to do Activity 4—it's required.

Activity 2 Page 6

Objective 1: On a diagram, identify these parts of the human digestive system: teeth, salivary glands, esophagus, stomach, small intestine, pancreas, liver, gall bladder, large intestine, rectum.

Sample Question: Match the letter of each digestive part with the number of the arrow that points to it in the diagram on the next page.

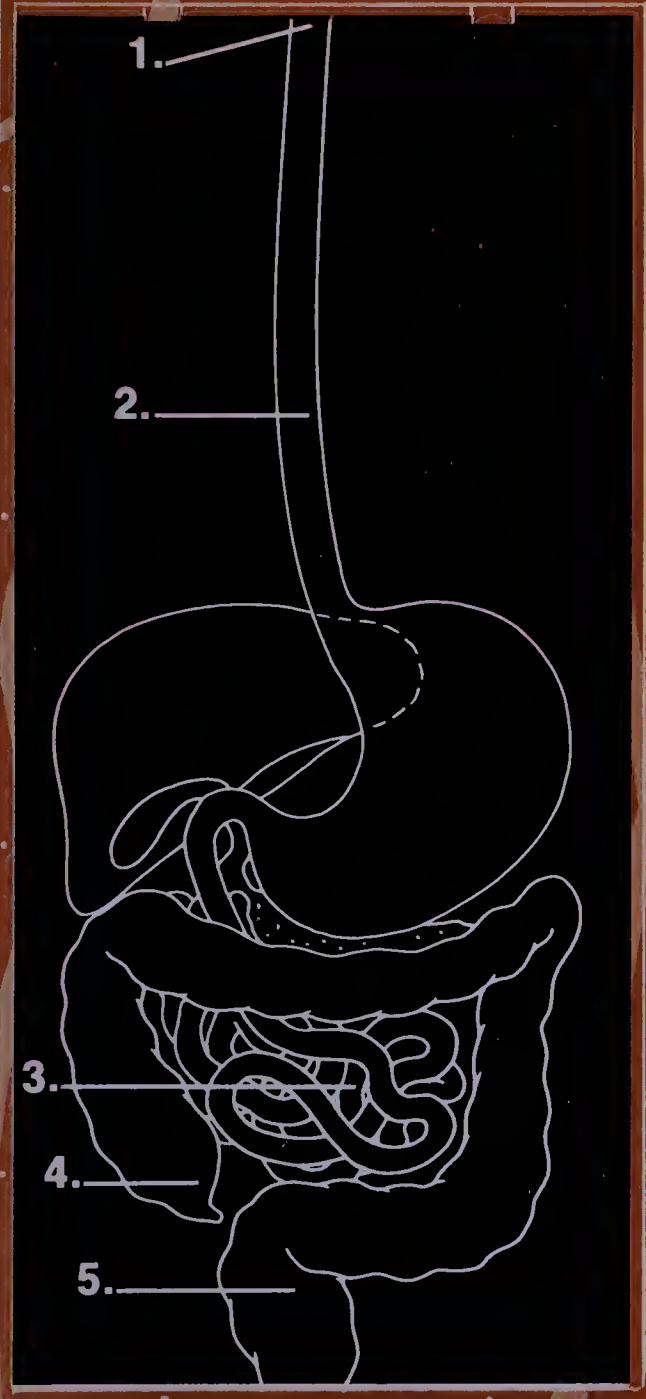
a. esophagus
b. large intestine
c. rectum
d. small intestine

Objective 2: Describe what each of these parts of the digestive system does during digestion: teeth, salivary glands, esophagus, stomach, small intestine, pancreas, liver, gall bladder, large intestine, rectum.

Sample Question: Match each part of the digestive system in List A with what it does in List B.

List A
a. liver
b. gall bladder
c. pancreas
d. rectum

List B
1. stores urine
2. stores bile
3. collects solid wastes
4. produces juices for sugar, fat, and protein digestion
5. makes bile



Activity 3 Page 12

Objective 3: Describe how the digestive parts work when you swallow.

Sample Question: Which of these things happen(s) during swallowing?

a. The mouth is usually closed.
b. The tongue moves down and forward.
c. The air passage to the lungs is closed.
d. The air passage from mouth to nose is closed.

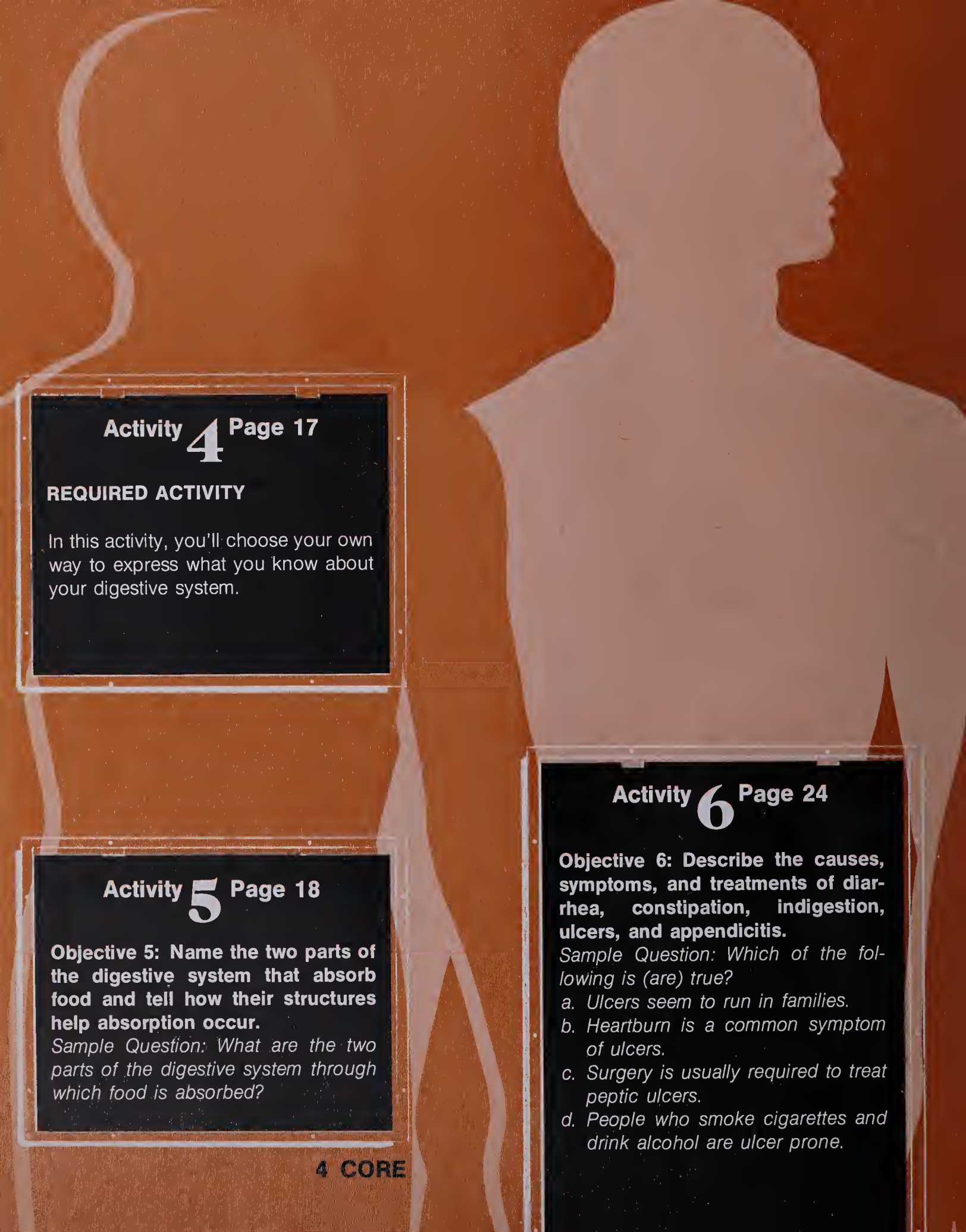
Objective 4: Describe peristalsis and name the digestive parts in which it occurs.

Sample Question: Where and how does peristalsis occur?

a. in the pancreas by the tightening and relaxing of muscles
b. in the esophagus by the pull of gravity
c. in the small intestine by the tightening and relaxing of muscles

Answers

1. a–1 and 2, b–4, c–5, d–3 2. a–5, b–2, c–4, d–3 3. a, c, d. 4. c.



Activity 4 Page 17

REQUIRED ACTIVITY

In this activity, you'll choose your own way to express what you know about your digestive system.

Activity 5 Page 18

Objective 5: Name the two parts of the digestive system that absorb food and tell how their structures help absorption occur.

Sample Question: What are the two parts of the digestive system through which food is absorbed?

Activity 6 Page 24

Objective 6: Describe the causes, symptoms, and treatments of diarrhea, constipation, indigestion, ulcers, and appendicitis.

Sample Question: Which of the following is (are) true?

a. *Ulcers seem to run in families.*
b. *Heartburn is a common symptom of ulcers.*
c. *Surgery is usually required to treat peptic ulcers.*
d. *People who smoke cigarettes and drink alcohol are ulcer prone.*

Activity 7 Page 25

Objective 7: Describe how hormones regulate the flow of digestive juices.

Sample Question: Which statement is true?

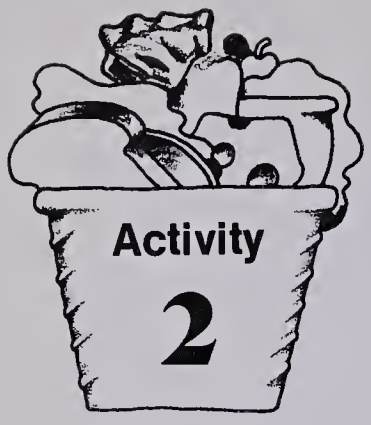
a. *A decrease in the amount of thyroxine slows down the pituitary.*
b. *A decrease in the amount of thyroxine increases the production of TSH.*
c. *An increase in the amount of thyroxine speeds up the pituitary.*
d. *An increase in the amount of thyroxine increases the production of TSH.*

Objective 8: Tell what happens to every bit of food that enters the body.

Sample Question: Human wastes, or feces, consist mostly of

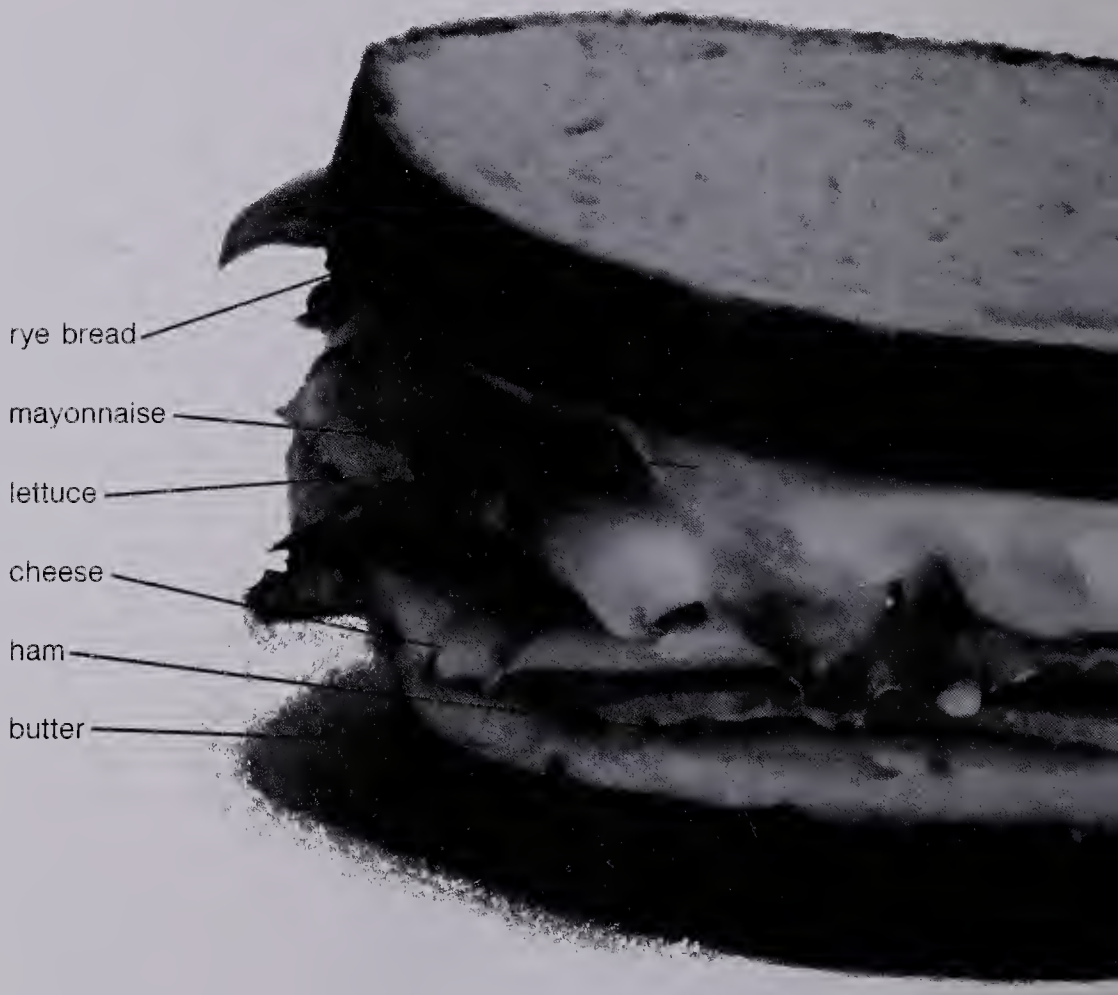
a. *cellulose, extra fats, mucus, and bacteria.*
b. *proteins, fats, sugars, and water.*
c. *cellulose, starch, minerals, and vitamins.*
d. *bacteria, proteins, starch, and cellulose.*

Answers
5. stomach, small intestine
6. a, b, d 7. b 8. a



The Adventures of a Sandwich

Follow a ham and cheese on rye as it travels through the human digestive system. The different parts of the system do different things to the food.



1. Mouth

Teeth slice, tear, and mash each bite of sandwich into small chunks. Saliva moistens the food. Saliva also breaks down, or *digests,* some of the starch in the bread, changing it into sugar. The tongue pushes the food around and finally back toward the throat. By the time a bite of food is swallowed, it's a moist glob.

2. Esophagus

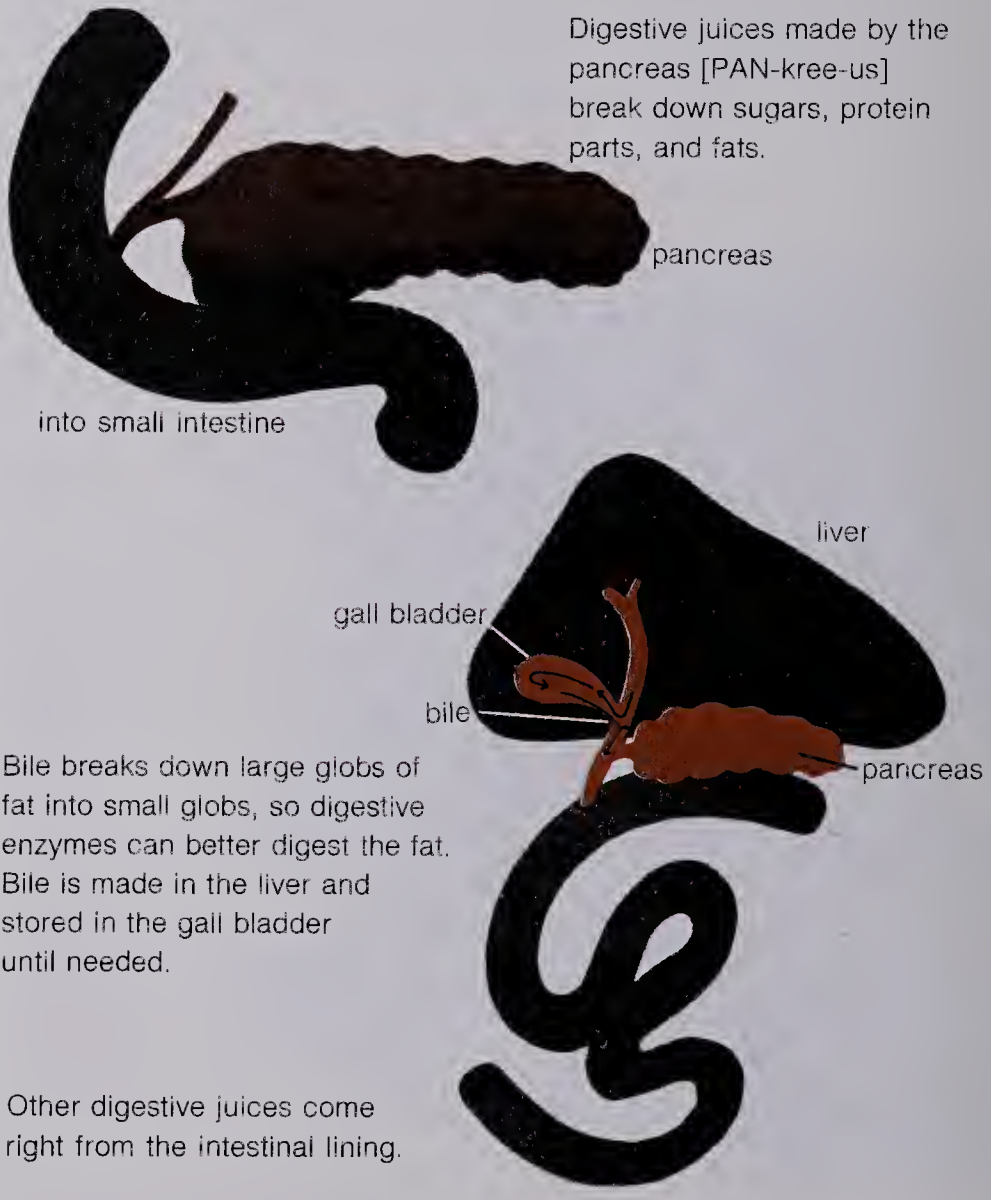
Swallowing the food moves it into a tube called the *esophagus* [ee-SOF-a-gus]. The walls of the esophagus move in and out, pushing the food along. The food leaves through a "trapdoor" into the stomach.

3. Stomach

The stomach has rough and ripply walls that churn the food around and mix it with stomach juices. Stomach juices digest some of the protein (from the ham and cheese), but only part-way. The juices do almost nothing to the fats (from the butter and mayonnaise). Then the food goes through another trapdoor.

4. Small Intestine

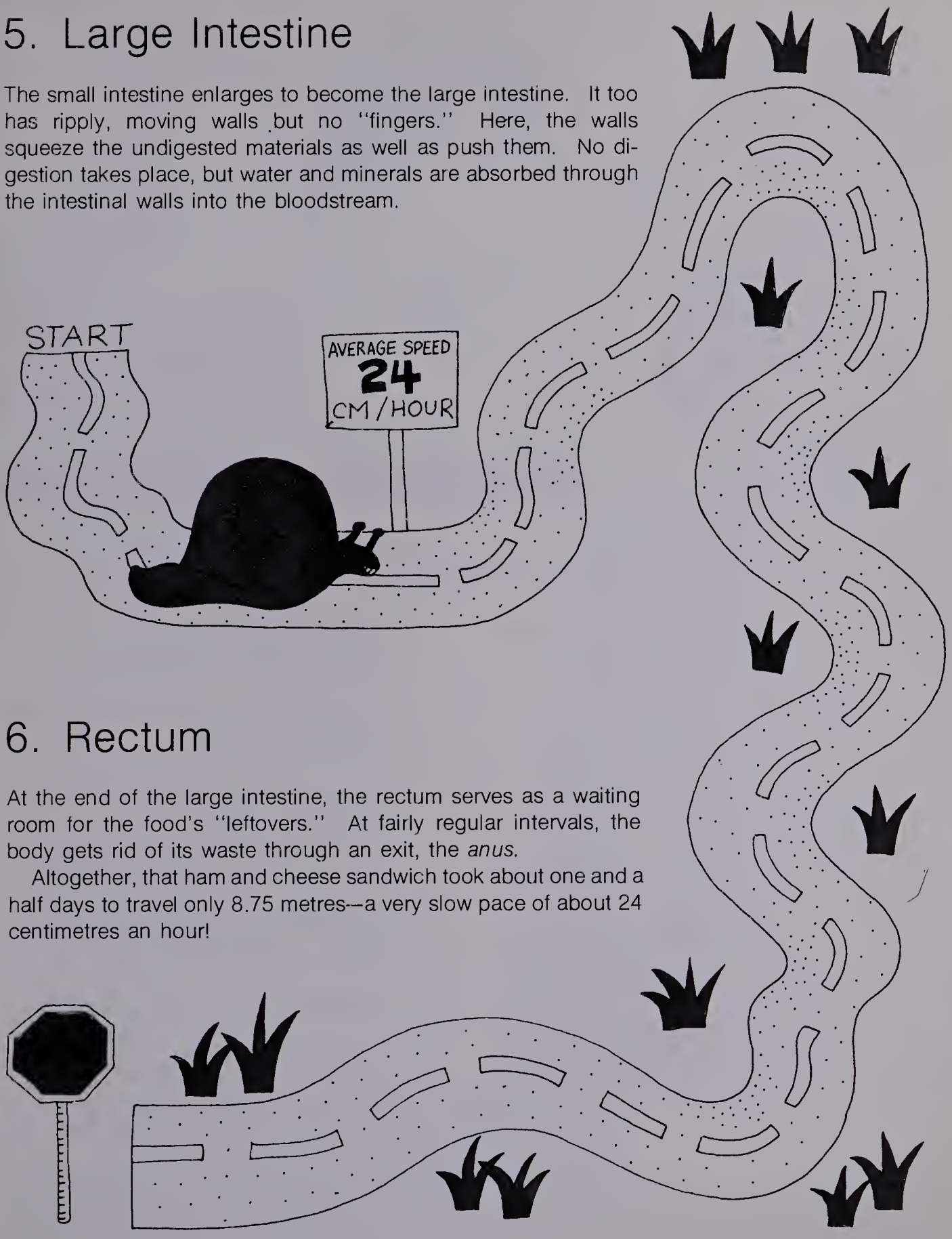
From the stomach, the food enters a tube called the *small intestine.* Now things really start to happen. Digestive juices pour in from all sides.



Like the walls of the esophagus, the walls of the small intestine move in and out. And like the stomach walls, the intestinal walls have big folds. But the intestinal folds are also covered with tiny, waving "fingers." These fingers soak up, or *absorb,* the digested substances; they give the broken-down food a passageway into the bloodstream. The food parts that aren't broken down, such as plant fibers from the lettuce, keep on moving through.

5. Large Intestine

The small intestine enlarges to become the large intestine. It too has ripply, moving walls but no "fingers." Here, the walls squeeze the undigested materials as well as push them. No digestion takes place, but water and minerals are absorbed through the intestinal walls into the bloodstream.



6. Rectum

At the end of the large intestine, the rectum serves as a waiting room for the food's "leftovers." At fairly regular intervals, the body gets rid of its waste through an exit, the *anus.*

Altogether, that ham and cheese sandwich took about one and a half days to travel only 8.75 metres—a very slow pace of about 24 centimetres an hour!

★ 2–1. Match each part of your digestive system with the statement that tells about it.

a. Esophagus	1. Makes juices that break down sugars, fats, and proteins.
b. Gall bladder	2. Long muscular tube that goes from mouth to stomach.
c. Large intestine	3. Moistens food and breaks down starches in mouth.
d. Liver	4. Food and juices are churned here.
e. Pancreas	5. Water and minerals go through its walls.
f. Rectum	6. Makes bile.
g. Saliva	7. Cut, tear, crush, and grind food.
h. Small intestine	8. Wastes are collected here.
i. Stomach	9. Stores bile.
j. Teeth	10. Most digestion occurs here.

If you had no trouble with Question 2–1, go on to the next activity you want to do. But if you had trouble, read about Professor Hodge-Podge's design and answer Question 2–2.

PROFESSOR HODGE-PODGE'S DESIGN

Professor Hodge-Podge has designed a new digestive system and plans to try it out in an artificial human. His plan is shown in Figure 2–1, where he has described what will happen in ten parts of the system. Examine the professor's diagram.

1. Food is broken into small dry pieces in the mouth.
2. Digestion begins in the esophagus.
3. Some food passes through the walls of the stomach, but nothing else happens here.
4. Juices from the pancreas are used in the stomach.
5. Food moves through the small intestine by gravity.
6. Food particles pass through pin-sized holes in the small intestine.
7. The small intestine has smooth walls.
8. Bile enters the large intestine.
9. Materials collected in the large intestine supply nutrients between meals.
10. Kidneys collect all wastes that are eliminated from the body.

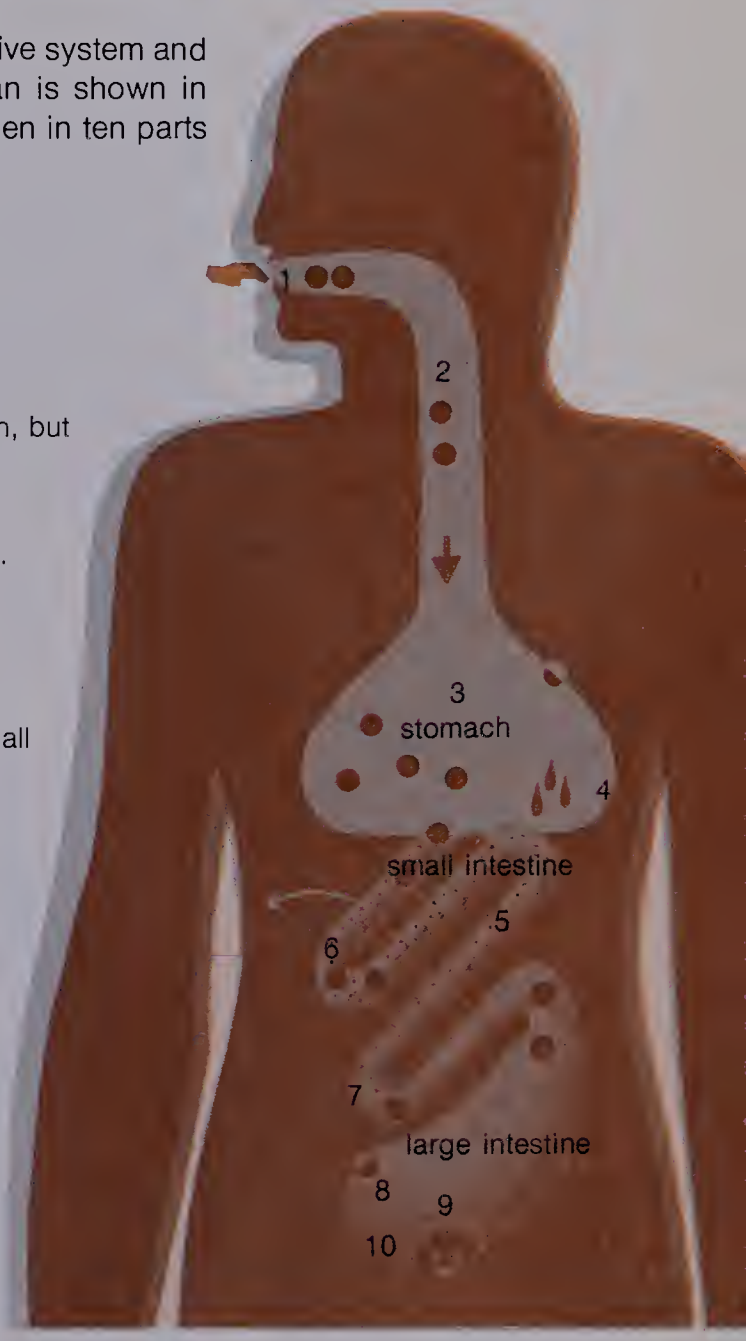
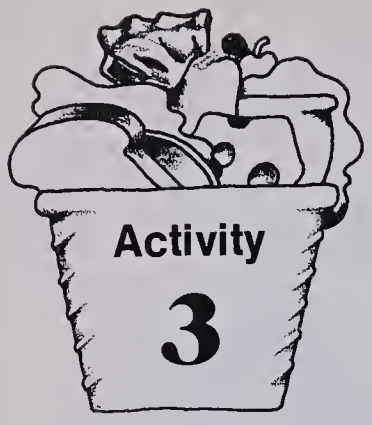


Figure 2–1

✔ 2–2. List any problems you see in the professor's diagram. Then make your own diagram to improve on Professor Hodge-Podge's. Number the parts on your diagram and describe each part and its function.



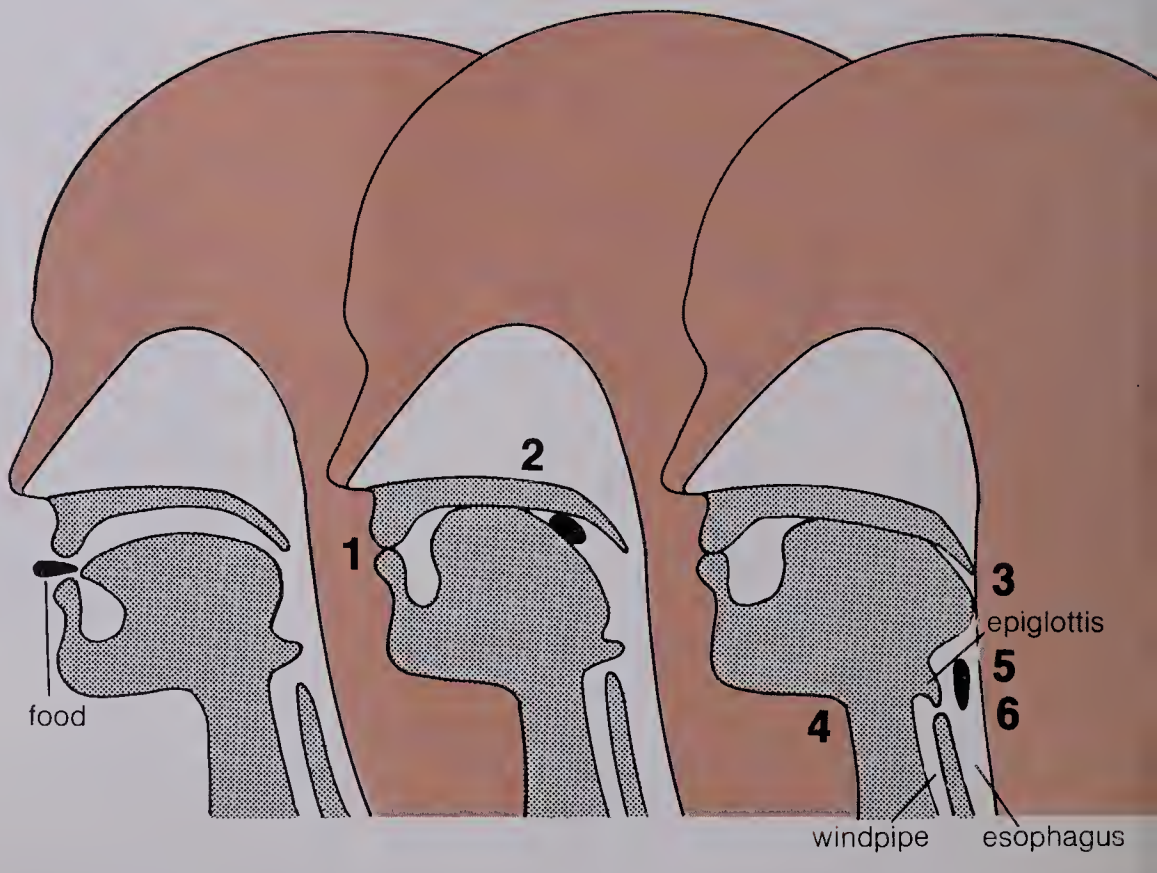
Down the Tube

How do you swallow? Get a piece of bread and chew some of it. Swallow slowly and try to feel what is happening in your mouth and throat.

Swallow another piece of bread as you think about each thing that happens. If you hold your hand on your throat, you'll feel the movement of your voice box.

Were you aware that all this happened?

1. Your lips closed.
2. The back of your tongue moved up and back, pushing the food down your throat.
3. At the back of your mouth, the opening to your nose closed.
4. Your voice box moved up.
5. The opening to your windpipe was covered by the epiglottis.
6. The food went into your esophagus.



★ **3–1. What body part pushes food from the mouth to the esophagus?**

★ **3–2. What body parts in your mouth and throat move during swallowing?**

Once food is pushed into the esophagus, it might seem that gravity alone could pull it through from there. But if that were true, how could food continue to move through your body when you're lying down? Or standing on your head?

It takes muscle power. There are two kinds of muscle in your esophagus, stomach, and intestines. One kind of muscle wraps around in a circular direction. The other kind runs up and down, or lengthwise. You can see the two kinds of muscle in Figure 3–1.

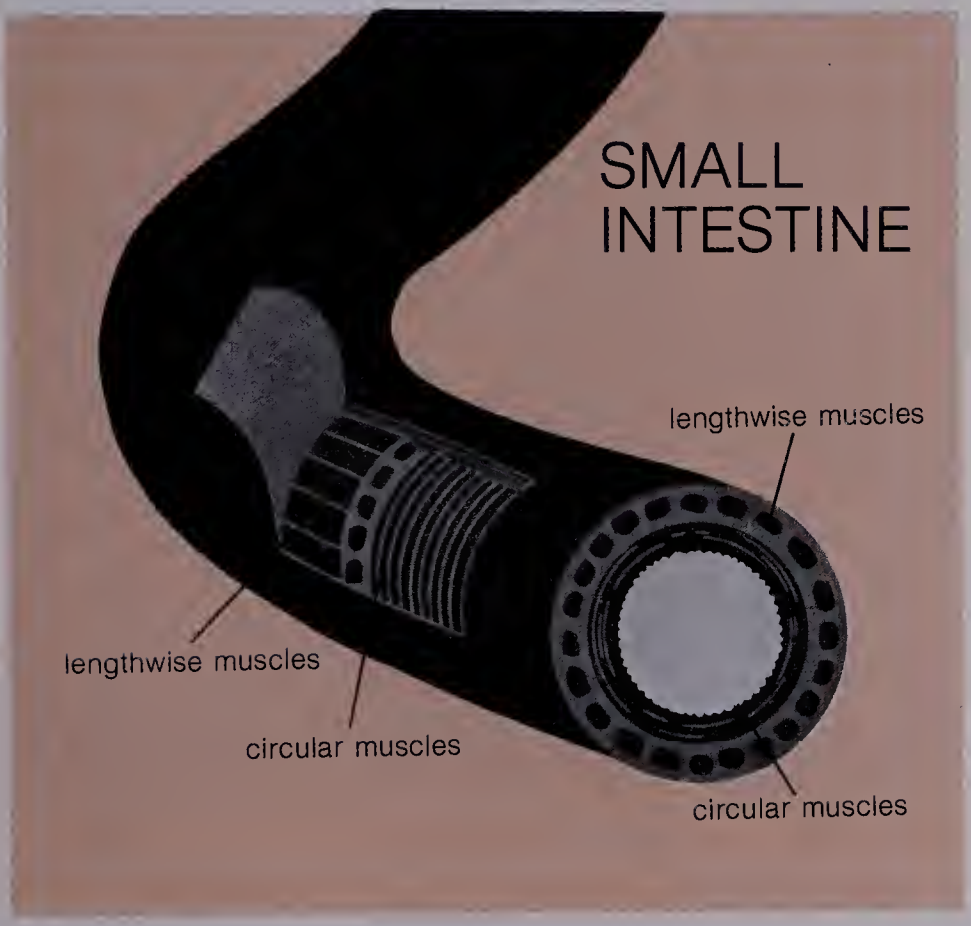


Figure 3–1

The circular and lengthwise muscles take turns tightening and relaxing. In this way, they squeeze food through the system. (See Figure 3–2.) It's like pushing toothpaste out of a tube.

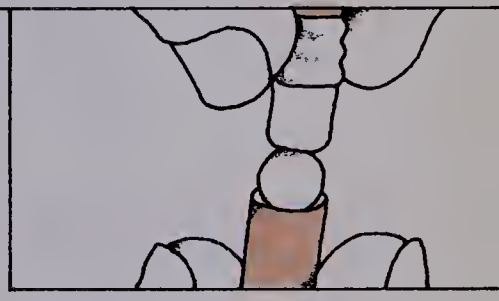
Figure 3–2

See for yourself how food is moved through your esophagus, stomach, and intestines. You will need the following items:

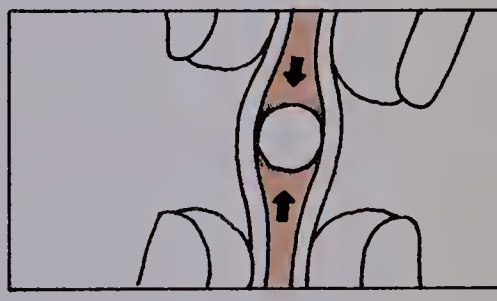
lubricating jelly or silicone grease
paper towels
plastic or metal ball, 7 mm in diameter
30 cm flexible rubber tubing, 6 mm in diameter

A. Put a dab of jelly on a paper towel. Roll the plastic or metal ball in the jelly until the ball is covered with it.

B. Insert the ball into one end of the rubber tube. Use a pencil to push the ball in as far as possibie. Wipe any jelly off your hands and the outer tubing with a paper towel.



C. With the thumb and index finger of one hand, squeeze the tube just above the ball. With the thumb and index finger of the other hand, squeeze the tube about 2 cm below the ball.



D. Push both hands toward the ball, then release the hand below the ball, still squeezing at the top. After the ball moves, relax the hand above the ball. Continue to squeeze, push, and release until the ball comes out the other end of the tube.

The pushing and squeezing motions of your fingers are like the actions of the two kinds of muscle in your esophagus, stomach, and intestines.

✔ 3–3. Which kind of muscle were you imitating when you pushed the tubing toward the ball? Which kind when you squeezed the tubing?

✔ 3–4. What did the ball in the tubing model represent?

The two kinds of muscle produce a rhythmic motion in your esophagus, stomach, and intestines. The motion is called *peristalsis* [per-i-STALL-sis]. In your stomach, it mainly churns the food around. In your esophagus and intestines, it mainly moves the food ahead.

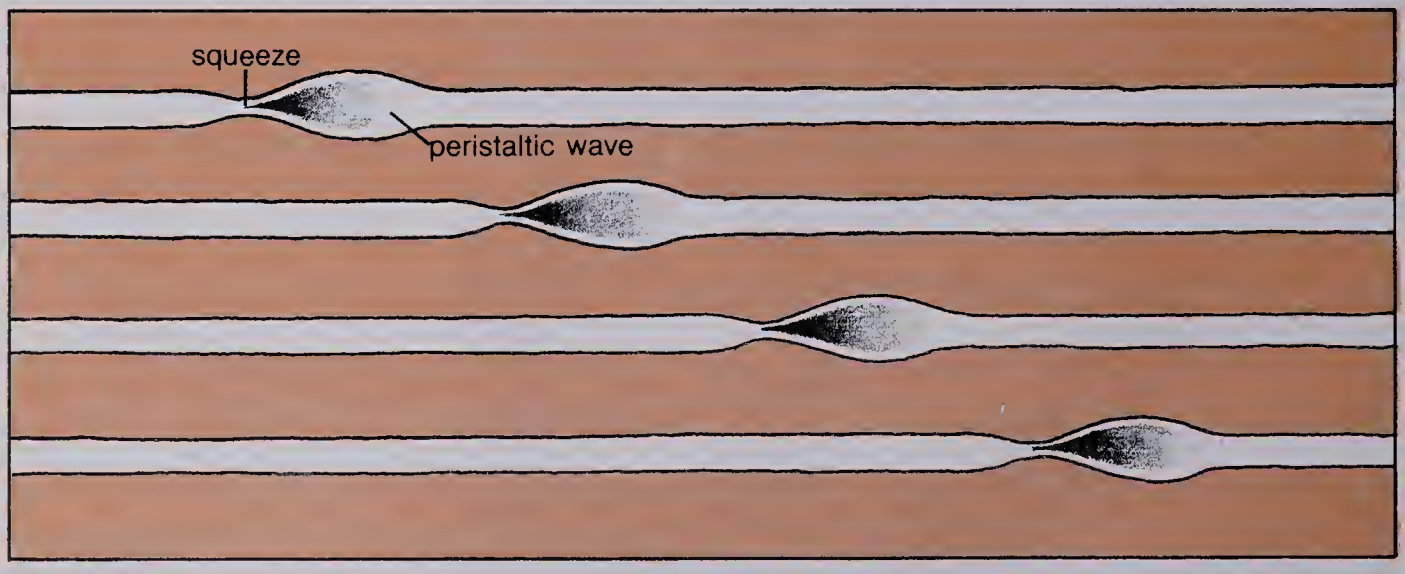


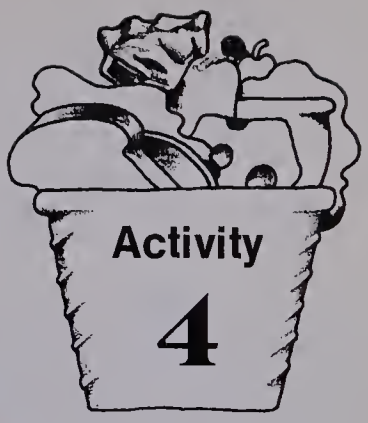
Figure 3–3

★ **3–5. What do muscles do to move food through the digestive system?**

✔ 3–6. Suppose the tightening waves in your esophagus suddenly started moving up instead of down. What would happen?

★ **3–7. Name three body parts in which peristalsis occurs.**

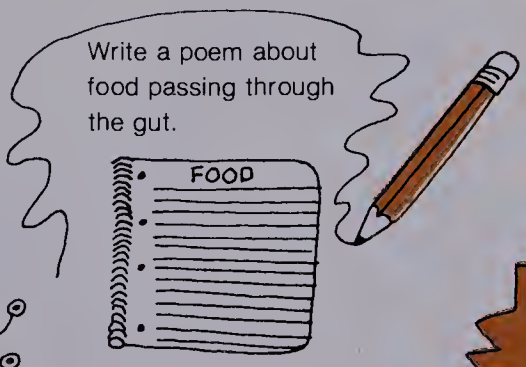
Express Yourself



In this activity, you'll choose your own way to describe "gut reactions." You may focus on only certain parts of the digestive system, or you may try to express how they all work together. You'll find some suggestions with the pictures on this page.

Make a mobile of objects or pictures that show real things in your environment (home, school, store, etc.) that do the same sort of work as your digestive parts.

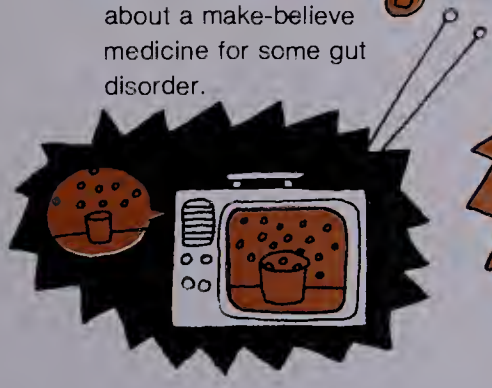
Write a poem about food passing through the gut.



What kinds of disorders are most often advertised on TV or in the printed media? How are the products the same or different in their effectiveness?

Make a collage of objects or pictures that express the various ways the digestive parts work.

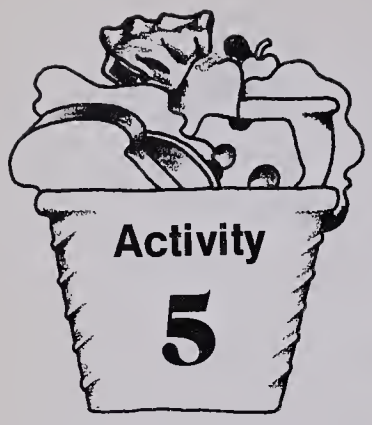
Plan a TV commercial about a make-believe medicine for some gut disorder.



Whatever method you choose, your final product should include one or more of the following ideas:

Feedback in the digestive system
How things are moved through the gut
The breakdown and absorption of foods in the gut
The elimination of waste materials
Gut disorders

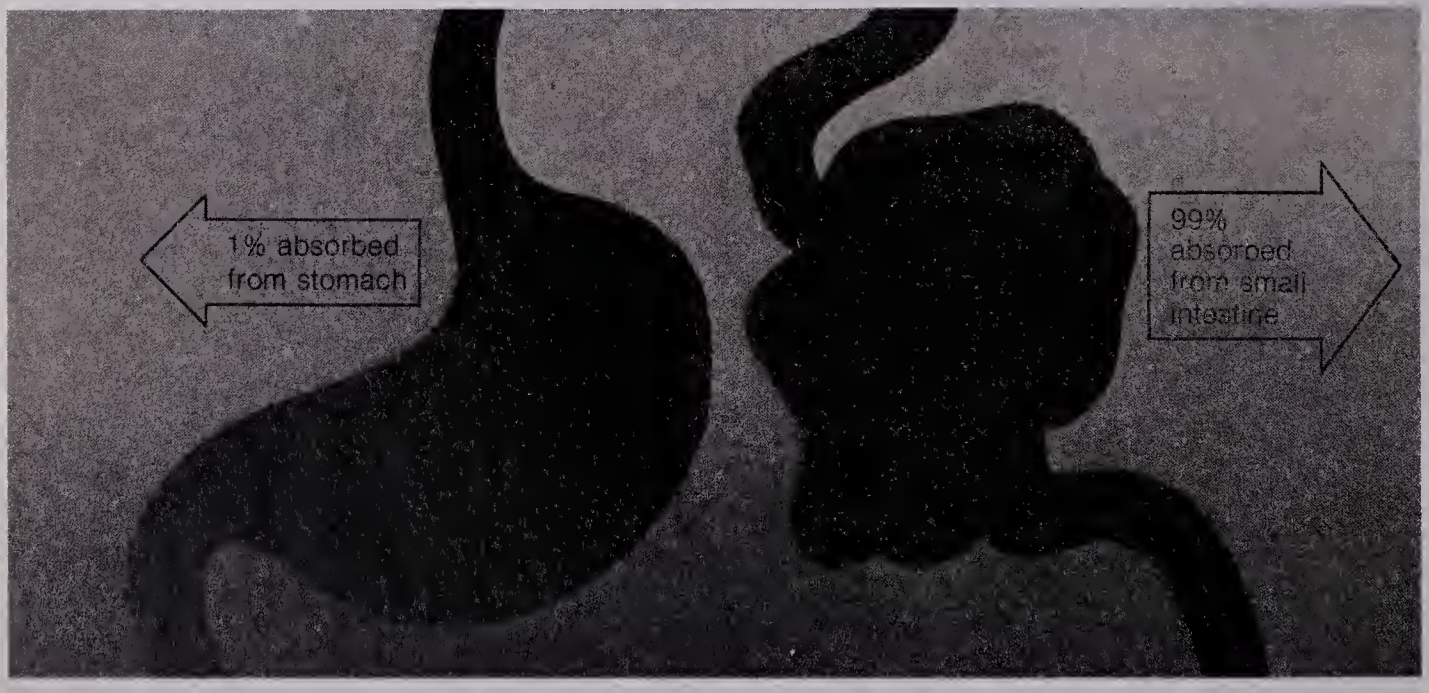
The form of expression is up to you. You may want to join talents with a friend for a combined effort. Hand in your finished product to your teacher.



Like a Sponge

Your stomach is a marvelous thing. It stretches to hold all the food and drink you send down. If the stomach didn't stretch, you would eat a lot less at each meal, but you'd have to eat many more meals.

The stomach sloshes and churns food into a thin paste. Some food is partly digested here, but very little food is absorbed through the stomach walls into the bloodstream.



Most digestion and absorption take place in the small intestine. How does the small intestine do this? And how can your stomach hold all the snacks you eat on top of meals?

Both the saclike stomach and the tubelike small intestine have walls with closely packed folds (Figure 5–1). The folds play an important part in the movement, mixing, and absorption that occur in the stomach and small intestine.

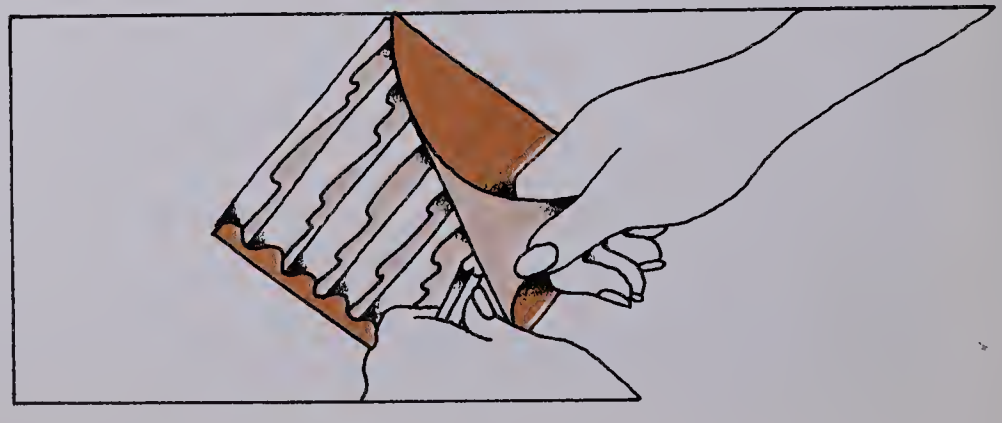
Figure 5–1

Such folds increase the *surface area* of the gut—the amount of gut that food can come in contact with. To see this, you'll need:

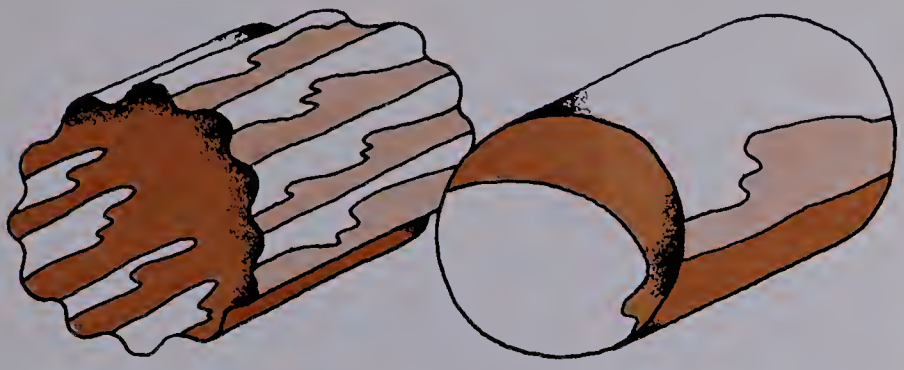
scissors
metric ruler
notebook paper
corrugated cardboard, 10 cm × 10 cm
container of water

A. Cut the notebook paper into a piece 10 cm × 10 cm. Place the paper on top of the piece of cardboard to check that they are the same size. Set the piece of notebook paper aside.

B. Carefully remove the paper covering from *both* sides of the corrugated cardboard. Sliding a sharp pencil along the grooves will help to break away the paper.



C. Roll the piece of notebook paper and the cardboard into tubes. The tubes should be the same size.



✔ 5–1. Look at the two tubes. What do you think are some advantages of a corrugated wall over a smooth wall?

D. Wet the piece of cardboard and flatten it out on a tabletop. Compare its size with the piece of notebook paper.

✔ 5–2. Which wall, the corrugated or smooth, has the greater surface area?

The surface area of the gut is increased by the folds. This means that more surface is exposed to food as it passes through the stomach and small intestine. This in turn aids digestion in the stomach and digestion and absorption in the small intestine.

★ **5–3. Suppose the small intestine had smooth walls instead of folds. How would this affect the way food moved through the intestine? Explain your answer.**

★ **5–4. How would a smooth-walled small intestine affect absorption? Explain your answer.**

The folds in the small intestine are more complicated than those in the stomach. In the small intestine, the folds are covered with small fingerlike projections called *villi* (Figure 5–2). The motion of the folds and villi helps move food.

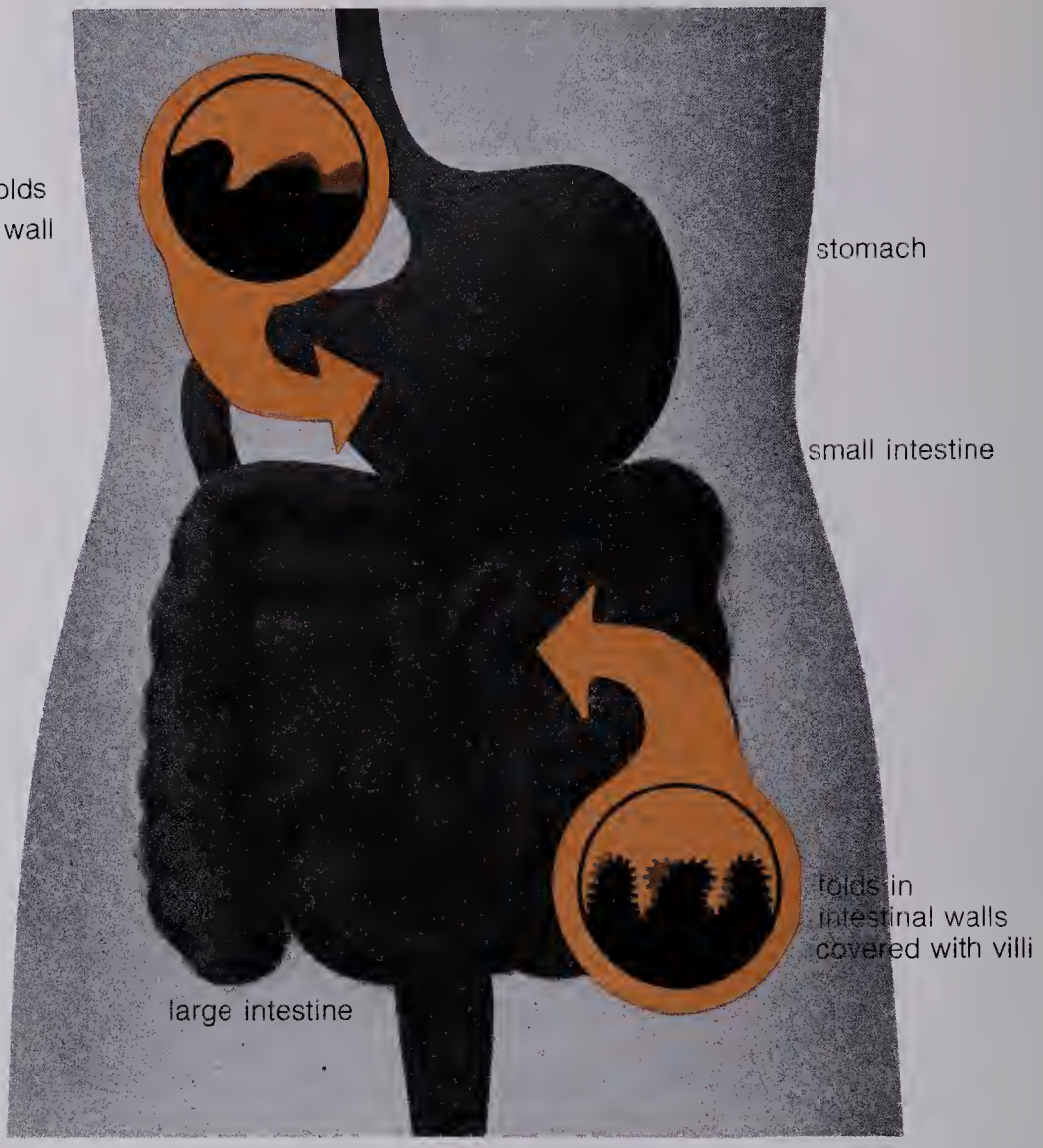
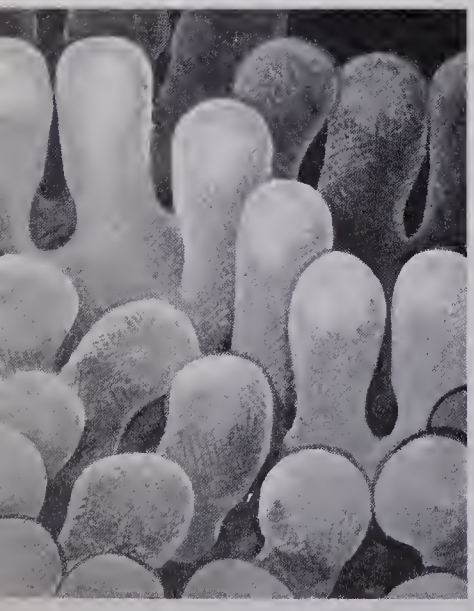


Figure 5–2



Villi are about the size of the commas on this page. They make the lining of the small intestine look like a bath towel with fuzz that is always moving. Because of the villi, the surface area of the small intestine is about the size of a basketball court. That's a lot of surface!

The villi soak up digested food like a sponge soaks up water. The cross section of villi in Figure 5–3 shows that they are rich in blood vessels. The digested food, once absorbed, enters the blood system and is carried to all parts of the body.

Figure 5–3

★ **5–5. How would fewer villi in the small intestine affect absorption?**

Just how do the villi absorb the food? This is not well understood, but there seem to be two ways. One way requires energy and the other way does not. Most sugar particles from food cannot pass through the walls without effort, but have to be "pulled" through. The process is not easily explained; the important thing is that it takes energy to absorb sugar particles.

Fat particles, on the other hand, can go through villi walls with no effort at all. They simply move from a place where there are a lot of fat particles to a place where there are fewer fat particles. This is an example of *diffusion*. It's like opening up an orange and having someone across the room smell it.

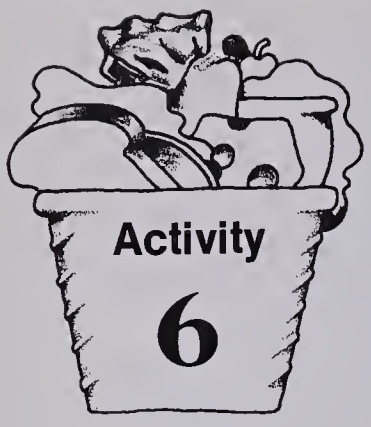
If you're not sure about the answer to any of the next three questions (Question 5–6, 5–7, or 5–8), do *Resource Unit 12.*

★ **5–6. What is meant by the word "diffusion"?**

★ **5–7. How does the size of food particles affect their passing through a wall or membrane?**

★ **5–8. How does the concentration of particles on each side of a wall or membrane affect diffusion?**

★ **5–9. Name the part of the gut where most digested food is absorbed.**



I Don't Feel Too Good, Doc

This activity includes a game in which you and a partner learn about patients' symptoms and try to diagnose what may be causing the problems. The "doctor" who better diagnoses and "treats" the conditions during the game will be the winner. You will need the following materials:

a partner
game *Diagnosis: Gut Reactions,* consisting of "Rules," "Memory Card," and 6 "Patient's Cards"
blank paper for keeping score

It will probably take you two days to play the game, and learn the symptoms and treatments for the different conditions. By the end of the game, you should be able to answer the following questions.

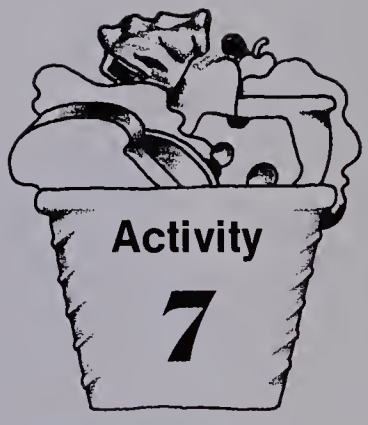
★ **6–1. Which word or group of words in each list does not belong with the other four?**

a. Laxative, diarrhea, enema, rectum, constipation
b. Gas pains, antacids help, sharp pain in lower right abdomen, eat slower, heartburn
c. Jaundice, dehydration, emotional upsets, anti-diarrheal agent, loose and watery bowel movements

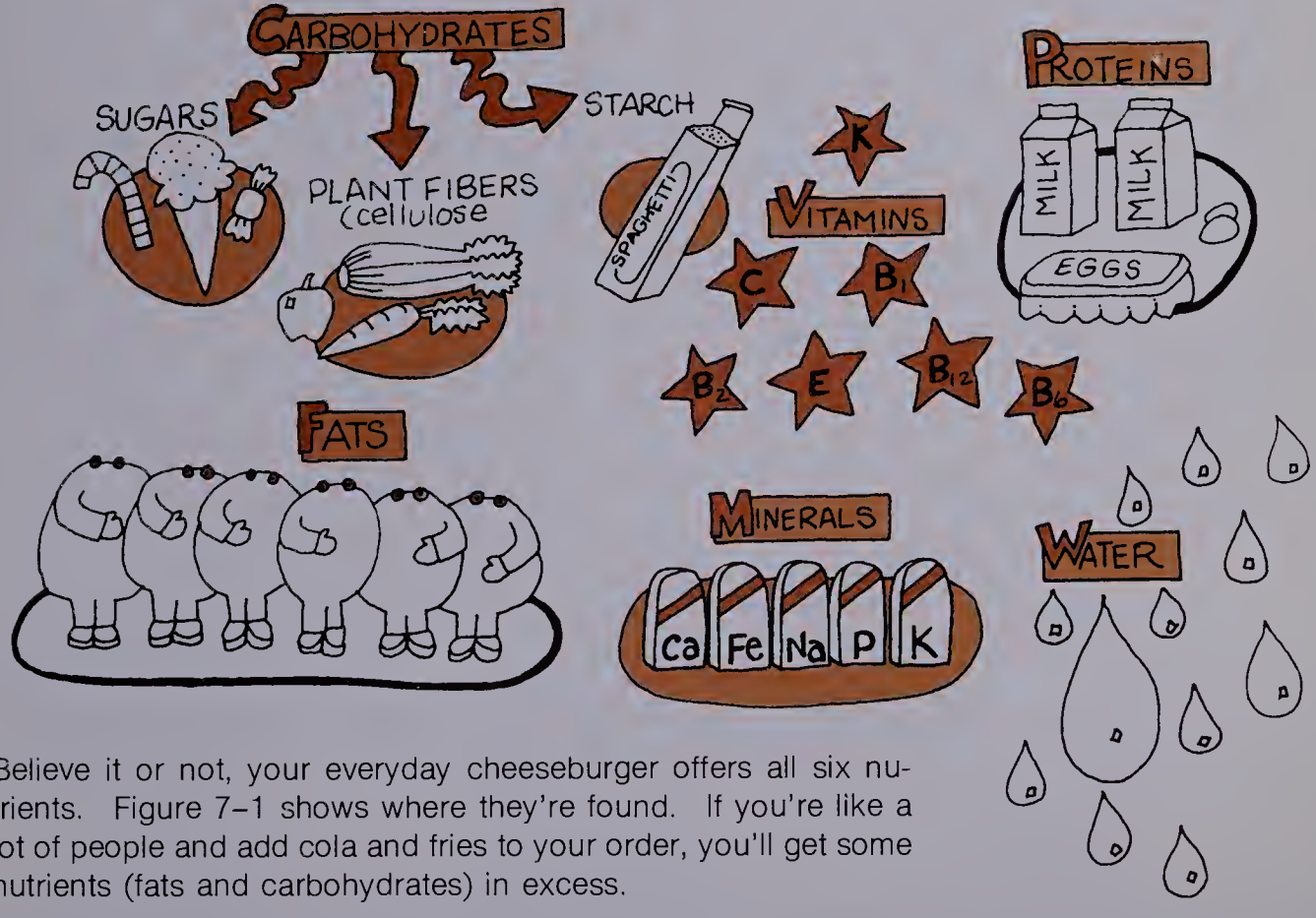
★ **6–2. Name one major cause, symptom, and treatment for acute appendicitis.**

✓ 6–3. Mary Claire and Tim spent the evening eating pizza, dancing, and generally having a great time. The next morning they each woke up with a bloated feeling, heartburn, and gas pains. What's wrong with Mary Claire and Tim? What should they do to relieve their symptoms?

Cheeseburger, Cola, and Fries, Please



Have you ever ordered that meal? One hamburger chain boasts that it has sold billions of such meals. You might even be one of its customers. Whatever you eat, most meals consist of six main nutrients.



Believe it or not, your everyday cheeseburger offers all six nutrients. Figure 7–1 shows where they're found. If you're like a lot of people and add cola and fries to your order, you'll get some nutrients (fats and carbohydrates) in excess.

WHAT'S IN A CHEESEBURGER?

PARTS	WATER	CARBOHYDRATES	FATS	PROTEINS	MINERALS	VITAMINS
Bun	★	★ (starch)	✓	✓	✓	✓
Hamburger	★		★	★	✓	✓
Cheese	★	✓	★	★	✓	✓
Salt					✓	
Butter	★	✓	★	✓	✓	✓
Tomato	★	✓ (cellulose)	✓	✓	✓	✓
Lettuce	★	✓ (cellulose)	✓	✓	✓	✓

★ Principal nutrients
✓ Nutrients present in small amounts

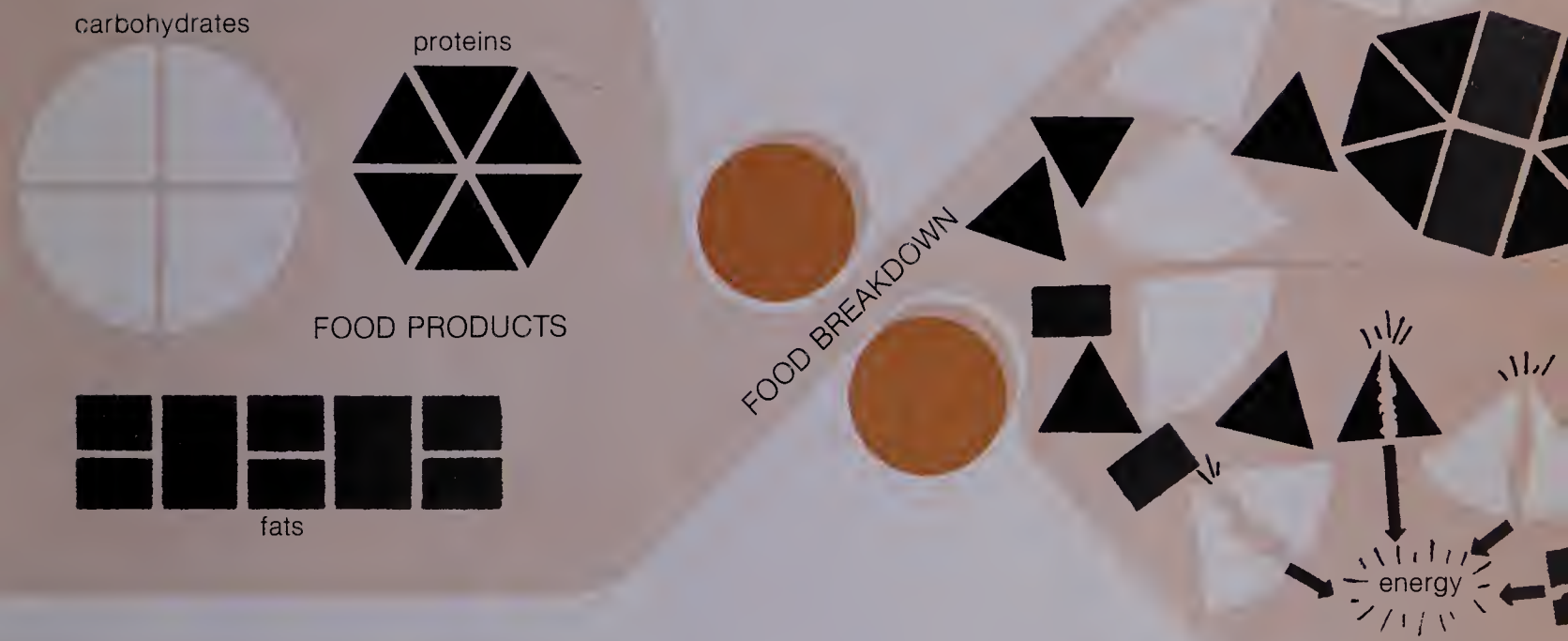
Figure 7–1

✔ 7–1. From what part or parts of a cheeseburger do you get the most proteins? Carbohydrates? Fats?

How does your body handle all these materials? Some it can't handle at all, like the plant carbohydrate *cellulose* [SELL-ya-loas]. The body simply eliminates the materials it can't use. But the materials it can use, it uses well. (The body may even use some nutrients to excess, such as fat.)

The body's digestive system first breaks usable materials into simpler forms. These simple materials are then absorbed into the bloodstream and carried to all of the body's cells. The body cells do one or two things with the simple materials.

Some food parts are used to build materials to keep the body in "good working order."



Some food parts are broken down even more to produce energy.

This process of breakdown and buildup is called *metabolism* [ma-TAB-a-liz-um]. Metabolism is an around-the-clock job for the body. If metabolism ever decided to take a day off, the body would be "out of business."

✔ 7–2. Describe the two main functions of metabolism.

Think for a minute about working 24 hours a day *every day*. As you can imagine, you'd need a good reason to keep going, or a mighty tough boss. The "bosses" of metabolism are special groups of cells that release chemical substances into the bloodstream. The groups of cells are *glands* and the chemical substances are *hormones*.

Glands and their hormones affect many bodily activities, but certain glands zero in on metabolism. You have a gland in your throat called the *thyroid.* The principal hormone released by the thyroid gland is thyroxine. Directly or indirectly, thyroxine helps to control most of the metabolic activities in your body. Figure 7–2 shows only six of those activities.

And who bosses the thyroid? Some gland has to make sure that the thyroid doesn't get carried away and run things too fast, or get lazy and let things go. That controlling gland is the *pituitary,* and it releases thyroid-stimulating hormone, or TSH for short.

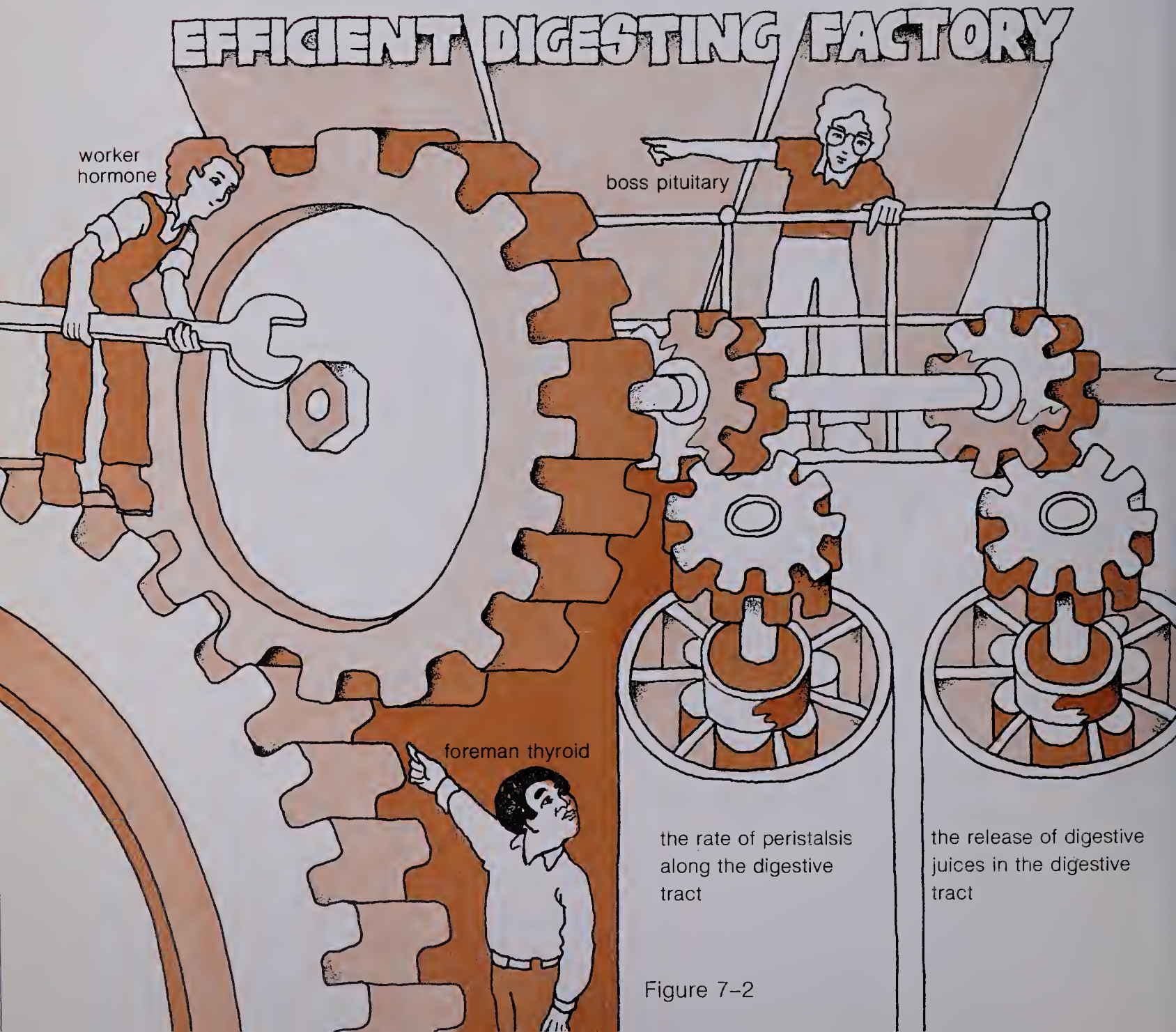
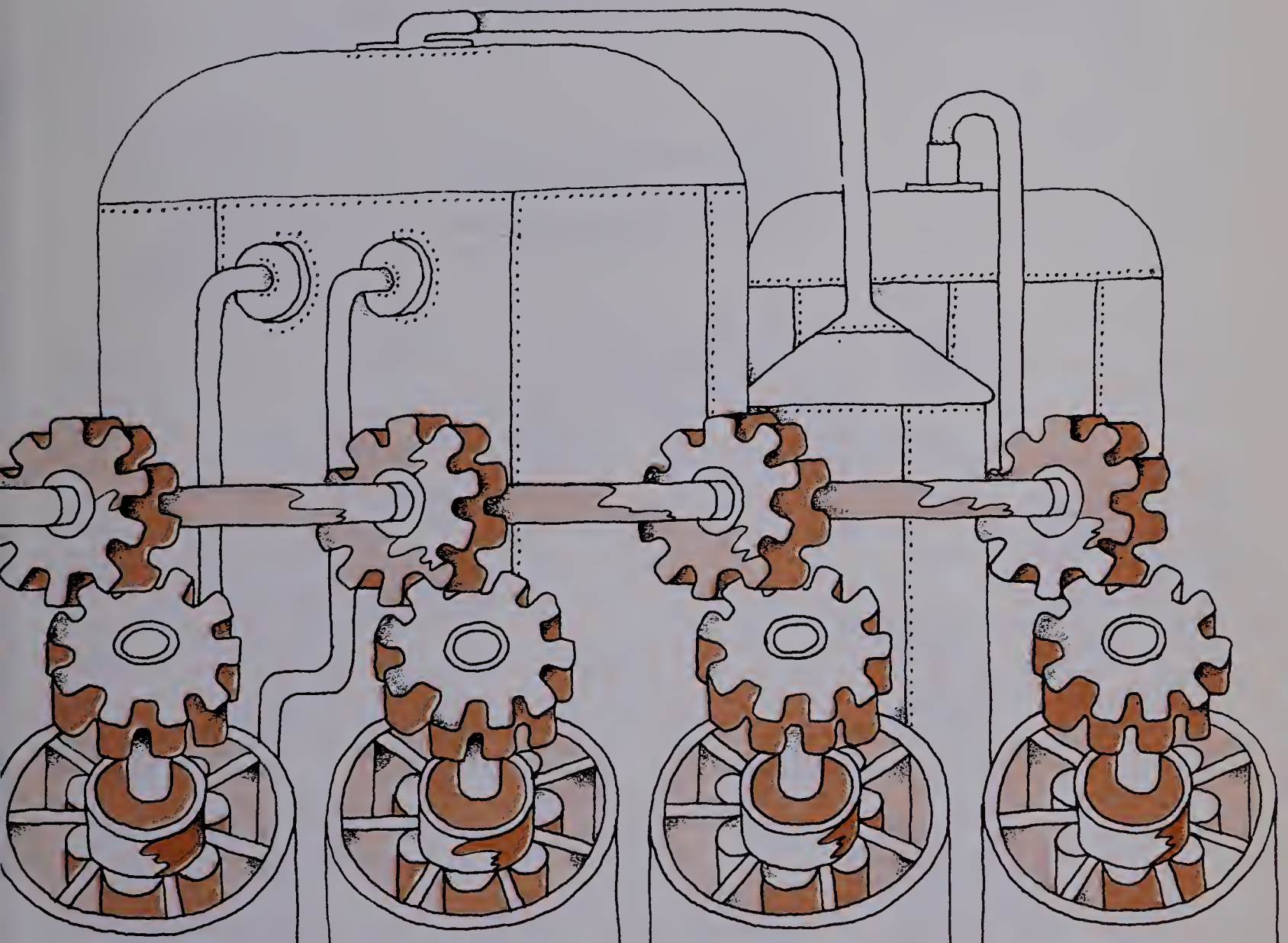


Figure 7–2

When the thyroid gets "lazy," the pituitary sends out TSH to stimulate the thyroid back into action. When the thyroid gets "carried away," the pituitary stops releasing TSH. Scientists call this kind of control *feedback*. Figure 7–3 shows how this works.

If this is the first time you have run into feedback, don't worry if its meaning isn't completely clear. You'll study feedback again in other minicourses. However, if you've seen feedback before, and are feeling uneasy about it, you may want to take a look at *Resource Unit 13*. It describes feedback in more detail.



the absorption of certain foods through the walls of the digestive tract

the transportation of absorbed foods to the body cells

the absorption of digested foods into the cells

the metabolism of carbohydrates, fats, and proteins in the cells

CORE 29

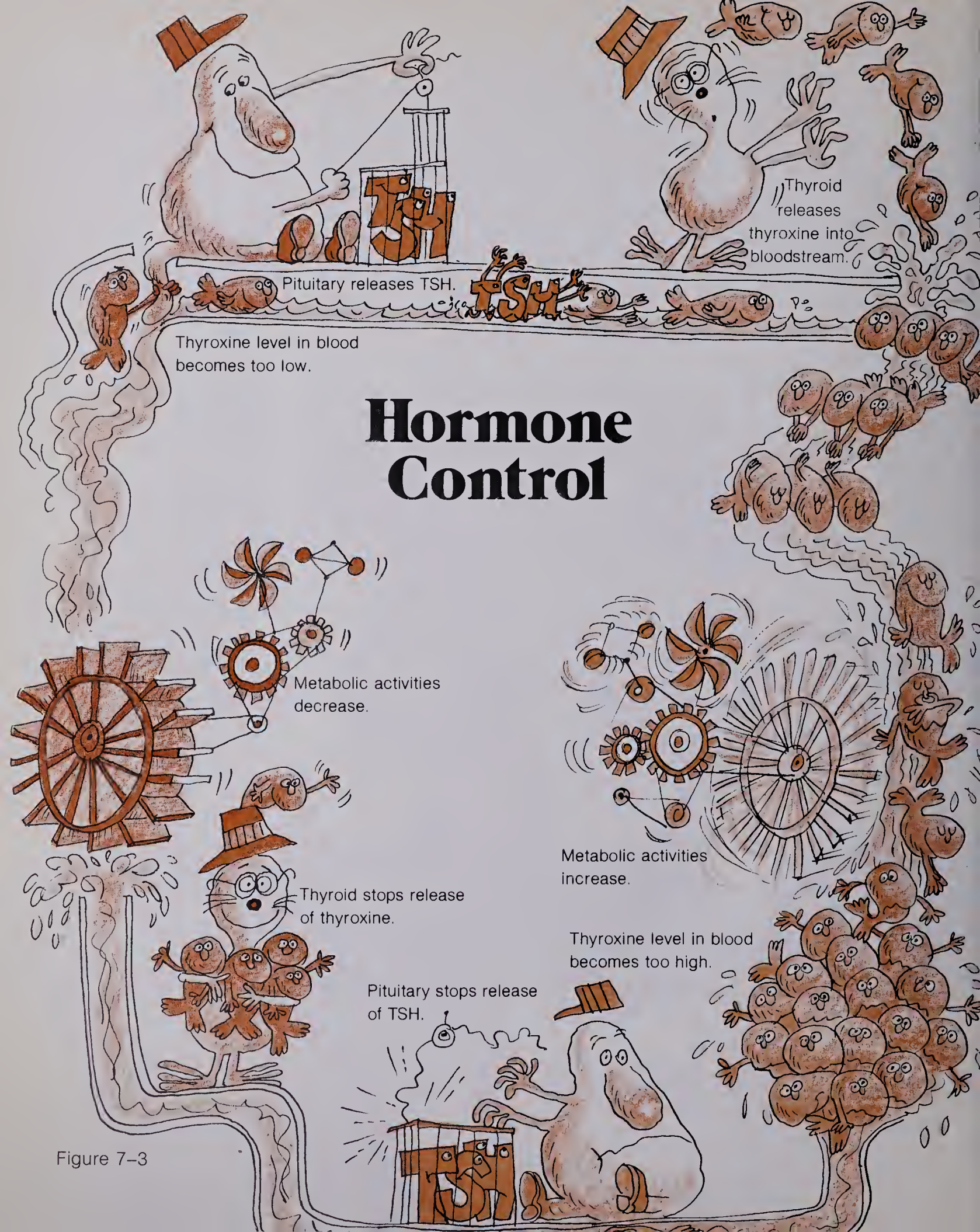

Hormone Control
Pituitary releases TSH.
TSH
Thyroid releases thyroxine into bloodstream.
Thyroxine level in blood becomes too low.
Metabolic activities decrease.
Thyroid stops release of thyroxine.
Pituitary stops release of TSH.
TSH
Thyroxine level in blood becomes too high.
Metabolic activities increase.

Figure 7–3

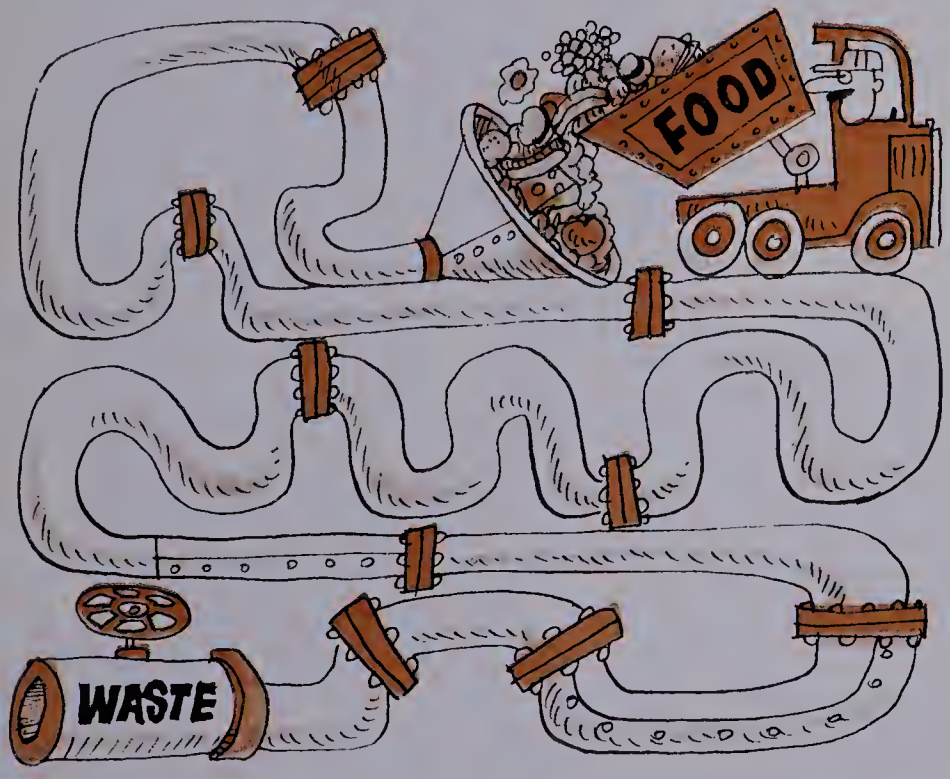
✓ 7–3. How does the pituitary gland regulate the activities of the thyroid gland?

✓ 7–4. Name six metabolic activities that are influenced by thyroxine.

★ **7–5. How is the release of digestive juices in the body sped up and slowed down?**

Remember the cheeseburger? Now you've seen how its usable materials are metabolized by the body. Not usable as food for humans are the cellulose (from the tomato and lettuce) and possibly some of the excess fat (from meat, butter, and cheese). Undigested materials aid in cleaning out the gut. They are passed out of the body as waste with the *feces.*

Feces consist of all sorts of waste materials—water; mucus from the mouth, stomach, and intestines; bile from the liver; intestinal bacteria; dead intestinal cells; roughage (mostly plant fibers); fats; and gases such as carbon dioxide.



Think of all the food you've ever eaten—all the meals, all the snacks, all the liquids. You probably figure all that stuff is gone for good once you swallow it. But not so! Everything you ever ate is still around. In a different form, but still around. Whatever enters your digestive system is either used or eliminated.

Suppose you could track the smallest particles, or atoms, of each food you ate. You would find that each atom becomes part of something else—either part of the waste feces or of some cell somewhere. No atoms are destroyed and no new atoms are made in the process. This is called the *law of conservation of matter* because it is true for changes in all kinds of matter.

This may be the first time you've met the law of conservation of matter. If so, don't worry if the meaning isn't completely clear. You'll run into conservation again in other minicourses. If you have seen this law before and are uneasy about it, you may want to read *Resource Unit 18.* It describes conservation in more detail. Apply this idea to a meal of cheeseburger, cola, and french fries. Figure 7–4 shows what happens to the main parts of the meal.

✓ 7–6. Which contents of the meal would mostly become part of the feces?

✓ 7–7. Which contents of the meal would mostly be used by the body?

✓ 7–8. Did you account for the six main nutrients (page 25) in Questions 7–6 and 7–7?

★ **7–9. How does Figure 7–4 illustrate the law of conservation of matter?**

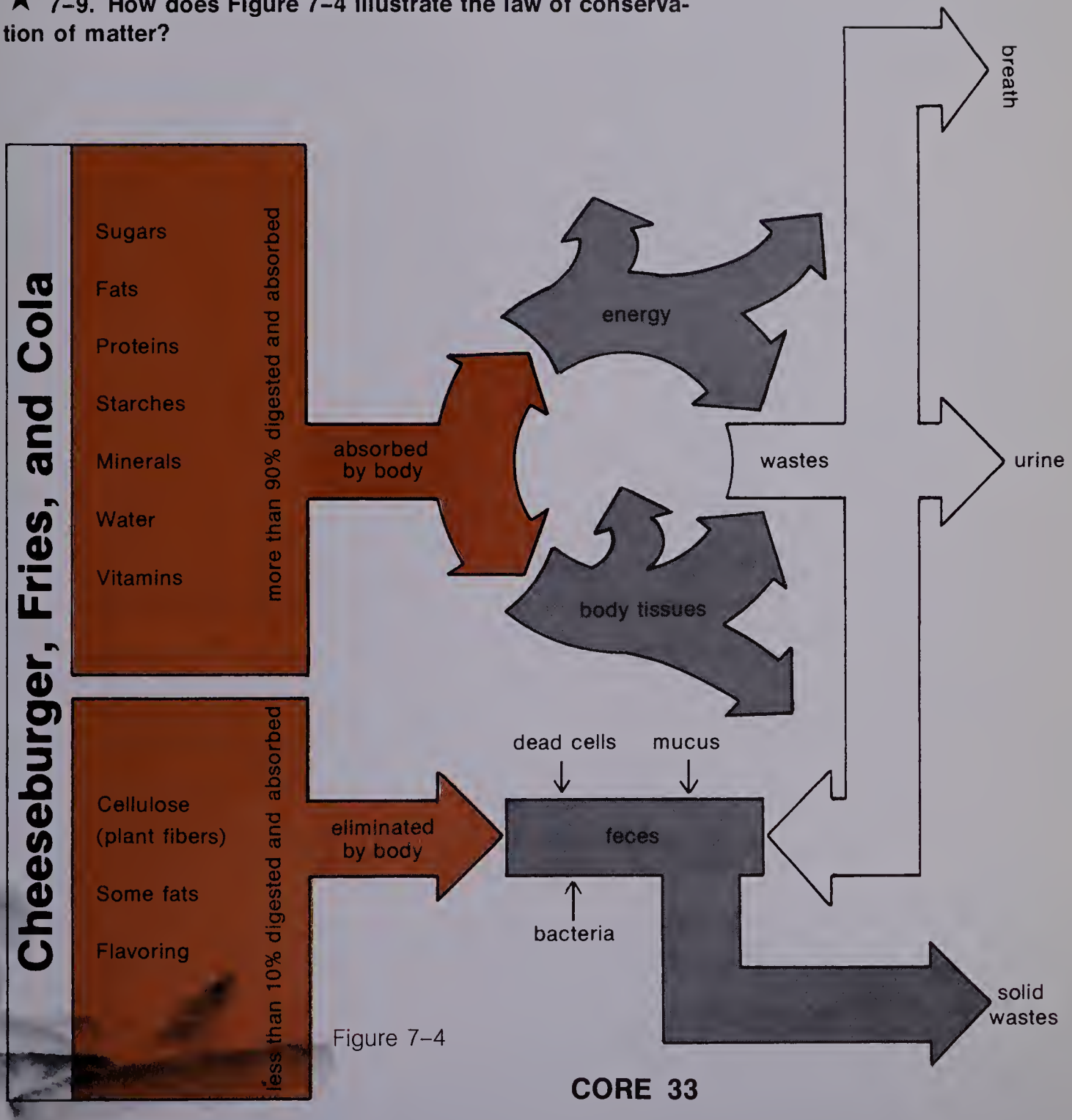


Figure 7–4

advanced

Activity 8 Planning

If you're not sure about Objective 9, do Activity 9 first. If you need to do the other two activities, you can do them in either order.

Activity 9 Page 36

Objective 9: Describe what a catalyst is and what it does in a chemical reaction.

Sample Question: Which of these statements is (are) true?

a. *Catalysts are not all alike.*
b. *Catalysts are unchanged by reactions.*
c. *Catalysts slow reactions down.*

Activity 10 Page 41

Objective 10: Describe the chemical composition of a digestive enzyme and explain what enzymes do in the digestive system.

Sample Question: Which of the following is (are) true of enzymes?

a. *They help break down food in the gut.*
b. *They help combine foods in the gut.*
c. *They help villi to move and absorb food.*
d. *They help prepare food for absorption through the gut walls.*

Objective 11: Predict how changes in pH, temperature, or concentration will affect the activity of enzymes.

Sample Question: What will increase the rate of enzyme activity?

a. *increasing the temperature from 5°C to 37°C*
b. *diluting the enzyme to one part in a thousand*
c. *adding saliva to an acid solution*

Activity 11 Page 56

Objective 12: Describe the digestion of starch and the action of amylase.

Sample Question: Which reaction is correct?

a. *starch + hydrochloric acid* $\xrightarrow{\text{amylase}}$ *starch + water*

b. *starch + water* $\xrightarrow{\text{amylase}}$ *maltose*

c. *starch* $\xrightarrow{\text{amylase}}$ *water + sucrose*

d. *starch + hydrochloric acid* $\xrightarrow{\text{amylase}}$ *maltose*

Objective 13: Describe the digestion of protein and the action of pepsin.

Sample Question: The enzyme pepsin

a. *is destroyed by acid.*
b. *splits protein into fatty acids.*
c. *digests protein in the stomach.*
d. *splits protein into its chain units.*

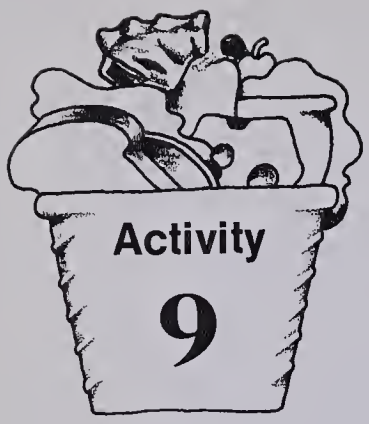
Objective 14: Explain and illustrate what is meant by the statement "digestive enzymes are specialized."

Sample Question: Which of these statements is (are) true?

a. *Digestive enzymes can work at any pH.*
b. *Amylase enzymes digest starch in the mouth and small intestine.*
c. *Pepsin digests protein in the stomach and small intestine.*

Answers

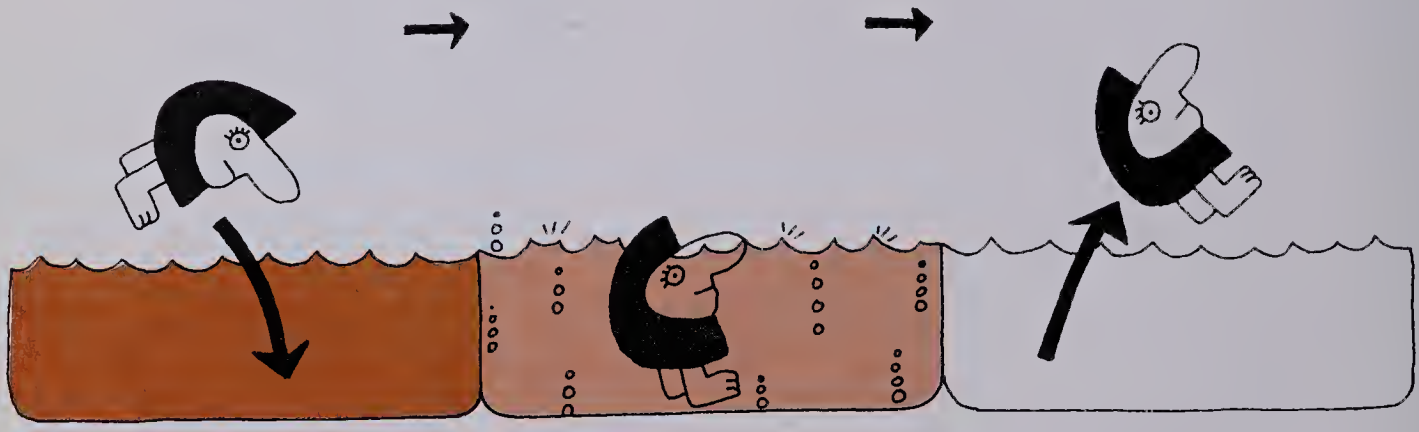
9. a, b 10. a, d 11. a 12. b 13. c, d 14. b



Catalysts

You may have heard the human body referred to as a very efficient machine. It certainly beats industry when it comes to demolition and construction. Take the breakdown of proteins, for instance. In the laboratory, proteins must be boiled in strong acid for about 24 hours before they will break down into simpler substances. Under normal conditions, your digestive tract gets the same results in less than four hours.

What makes the difference? A substance called a *catalyst* [KAT-al-ist]. Catalysts enter into and speed up certain chemical reactions. And though a catalyst becomes part of the reaction, it is still there, unchanged, at the end of the reaction. Catalysts are like shortcuts that reactions can take over and over again.



Catalysts are used to speed up many industrial processes, such as the breakdown of petroleum and the making of ammonia. Inside the body, catalysts are called *enzymes*. One important enzyme reaction that occurs inside the body is the breakdown, or decomposition, of hydrogen peroxide (H_2O_2), a poisonous by-product of certain cellular reactions. Hydrogen peroxide decomposes into harmless water and oxygen:

$$2H_2O_2 \xrightarrow[\text{(body temperature)}]{\text{enzyme}} 2H_2O + O_2$$

At body temperature, this reaction would go too slowly without the help of an enzyme. Likewise, at room temperature, a catalyst must be added to speed up the same breakdown:

$$2H_2O_2 \xrightarrow[\text{(room temperature)}]{\text{catalyst}} 2H_2O + O_2$$

To see this happening, you will need the following items:

gas generator
graduated cylinder
dilute hydrogen peroxide (H_2O_2)

CAUTION

Hydrogen peroxide can bleach your clothes and skin.

paper clip
metric ruler
5 copper-coated BBs
iron chloride
fresh raw liver
additional substances as suggested in Step G (page 40)

Before you begin, copy Figure 9–1 into your notebook. Leave space below your table; you'll be adding more data to the table when you do Step G.

DECOMPOSITION OF H_2O_2

CONTENTS OF TUBE	HEIGHT OF LIQUID IN STRAW		TOTAL DISTANCE LIQUID ROSE
	AT START	AFTER 2 MIN.	
H_2O_2			
H_2O_2 + copper			
H_2O_2 + iron chloride			
H_2O_2 + raw liver			

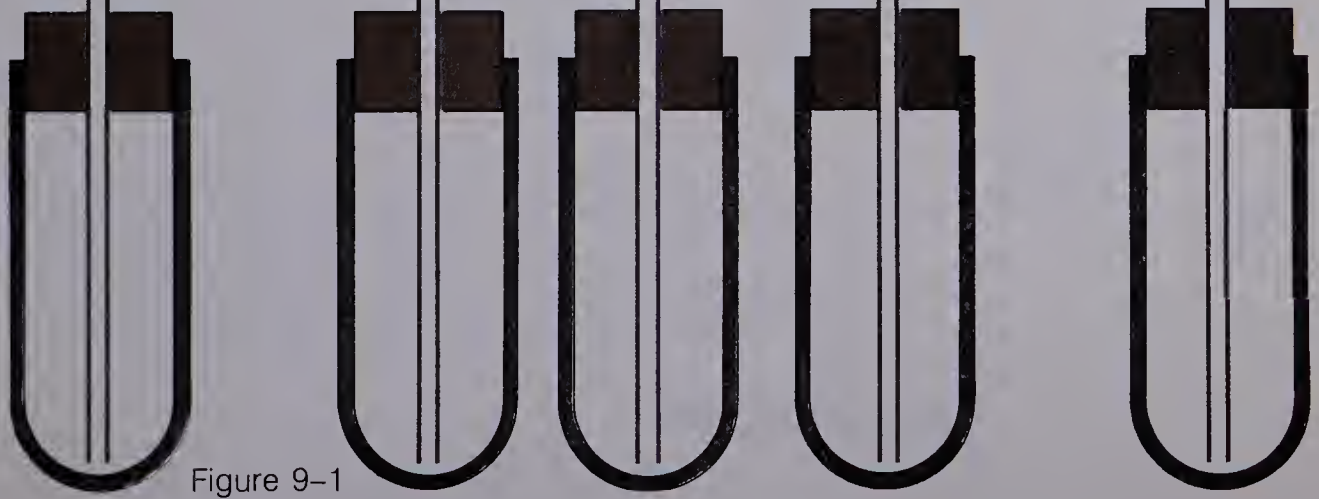
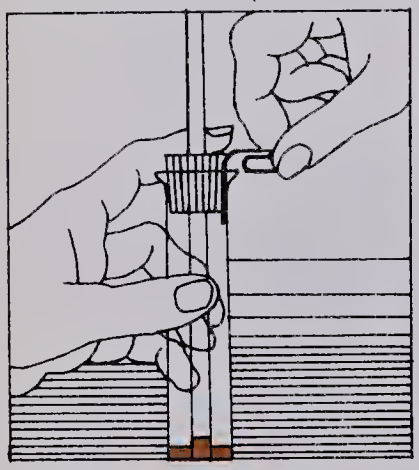


Figure 9–1

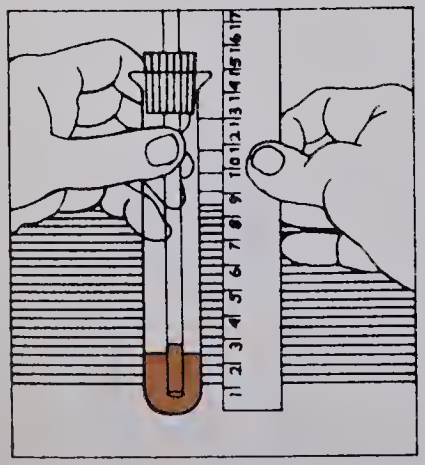
A. Remove the stopper from the gas generator. Add 5 ml of H_2O_2 to the test tube. If you have trouble using the graduated cylinder, refer to *Resource Unit 5.* Unbend one side of a paper clip and rest it on the mouth of the tube as shown.

IMPORTANT: Avoid holding the test tube at the bottom. This is to prevent heating the hydrogen peroxide.

Remove clip when liquid levels are about equal.



straw about 1 mm from bottom

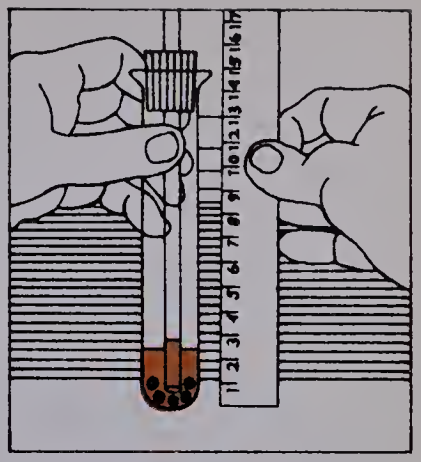


height of liquid in straw

B. Push the stopper into the test tube. Holding the stopper in place, pull out the paper clip. The liquid in the straw should be at or near the level of the liquid in the test tube. If not, remove the stopper and repeat the procedure with the paper clip until the levels are about equal.

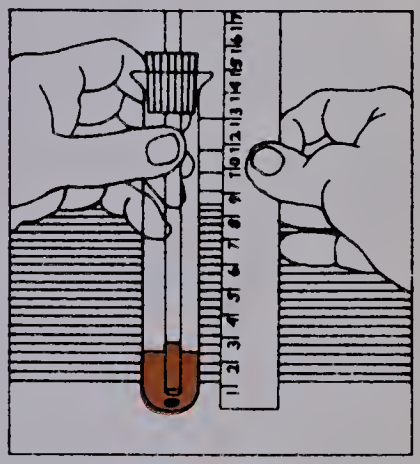
C. Place the metric ruler next to the gas generator and record in millimetres the height of the liquid in the straw. After 2 minutes, measure and record the height again. Compute and record the total number of millimetres the liquid rose.

D. Remove the stopper and add 5 copper-coated BBs to the liquid in the test tube. Using the bent paper clip, replace the stopper. Observe and record the liquid levels as you did in Step C. Then wash out the generator.



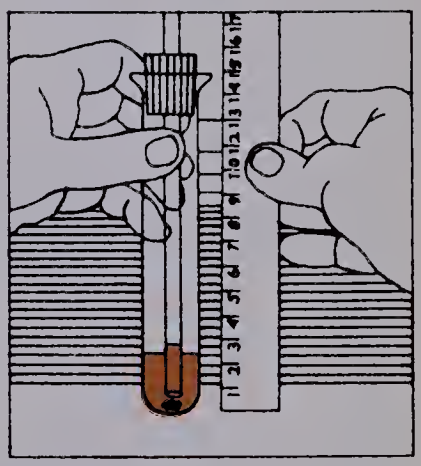
H_2O_2 + 5 copper BBs

E. To the clean generator, add 5 ml of H_2O_2 and a piece of iron chloride about the size of 2 BBs. Stopper the tube using the bent paper clip. Observe and record the liquid levels as in Step C. Then wash out the generator.



H_2O_2 + iron chloride

F. To the clean generator, add 5 ml of H_2O_2 and a piece of raw liver about the size of 2 BBs. Stopper the tube using the bent paper clip. Observe and record the liquid levels as in Step C. Then wash out the generator.



H_2O_2 + raw liver

✔ 9–1. Make a bar graph of your findings. (If you need help in making graphs, refer to *Resource Unit 4.*)

✔ 9–2. Which substance(s) increased the decomposition of hydrogen peroxide?

✔ 9–3. Which substance was the most active catalyst (raised the level of the liquid highest)?

✔ 9–4. Does your bar graph confirm the role of a catalyst in a reaction? Explain your answer.

✔ 9–5. Hydrogen peroxide bubbles when it is used to clean out a wound. What might this tell you about human tissues?

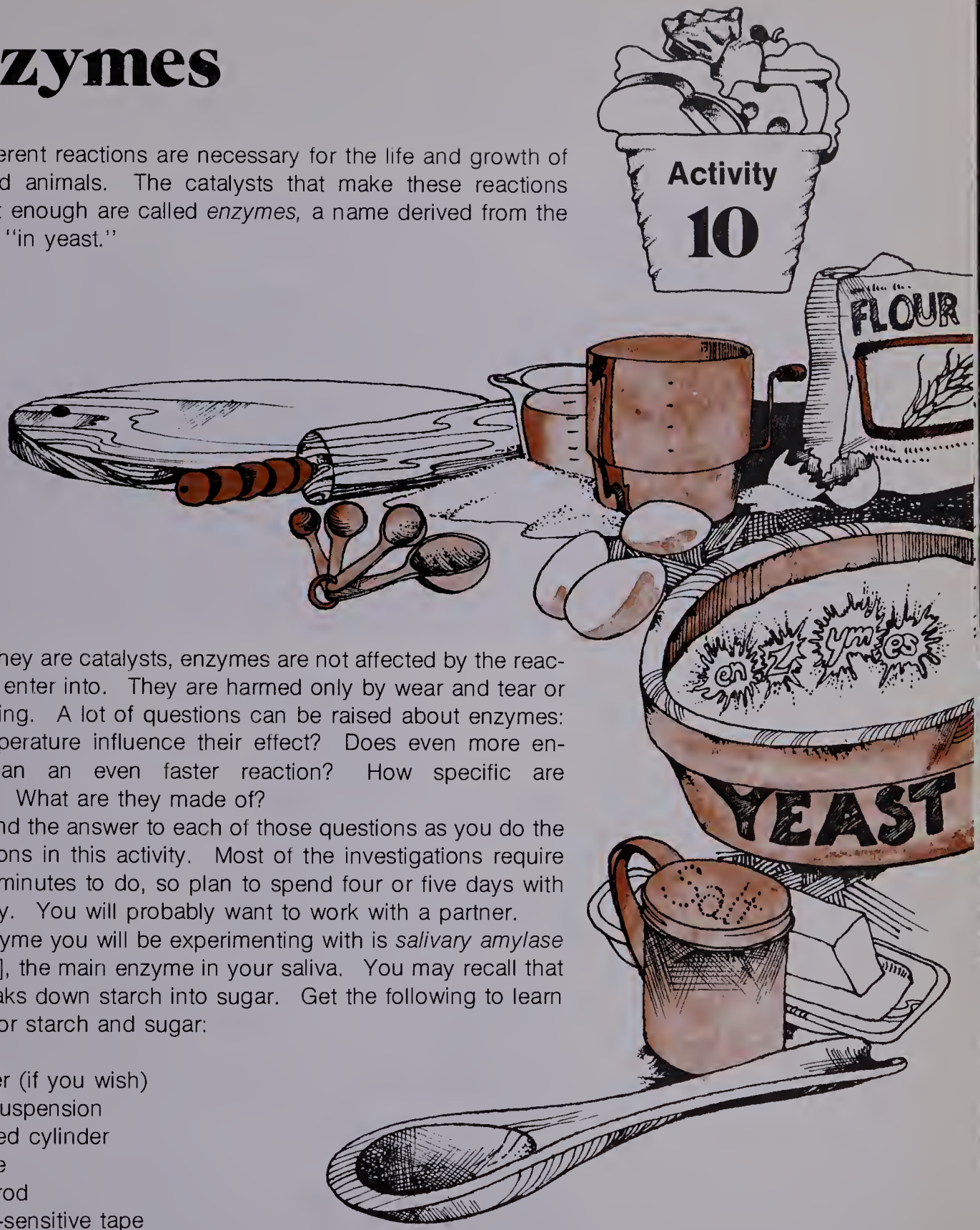
A lot of substances will catalyze the decomposition of hydrogen peroxide. And a lot won't.

G. Repeat the procedure with the gas generator, using 5 ml of H_2O_2 each time. Add various substances and record the results in your table. You might try plastic, glass, washing powder, candle wax, plant leaves, dried yeast, detergent, different metals, galvanized nails, steel nails, pencil "lead," sugar, table salt, saliva, and so on. Add the results to your graph.

✓ 9–6. Of the substances you tried in Step G, which, if any, acted as catalysts for the hydrogen peroxide reaction? Which did not?

★ **9–7. How does a catalyst affect the rate of a chemical reaction?**

Enzymes



Many different reactions are necessary for the life and growth of plants and animals. The catalysts that make these reactions occur fast enough are called *enzymes,* a name derived from the Greek for "in yeast."

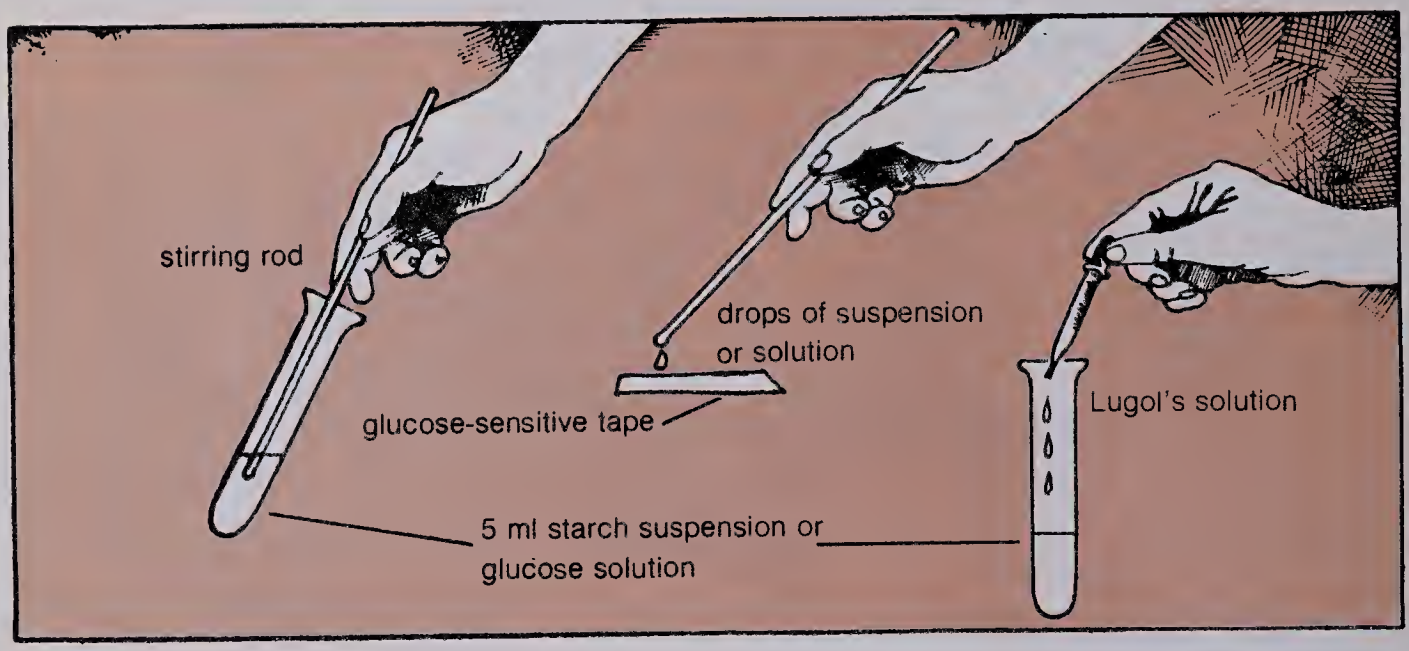
Because they are catalysts, enzymes are not affected by the reactions they enter into. They are harmed only by wear and tear or by poisoning. A lot of questions can be raised about enzymes: Does temperature influence their effect? Does even more enzyme mean an even faster reaction? How specific are enzymes? What are they made of?

You'll find the answer to each of those questions as you do the investigations in this activity. Most of the investigations require about 45 minutes to do, so plan to spend four or five days with this activity. You will probably want to work with a partner.

The enzyme you will be experimenting with is *salivary amylase* [AM-i-lays], the main enzyme in your saliva. You may recall that saliva breaks down starch into sugar. Get the following to learn the tests for starch and sugar:

a partner (if you wish)
starch suspension
graduated cylinder
test tube
stirring rod
glucose-sensitive tape
Lugol's solution
medicine dropper
glucose solution

Put 5 ml of starch suspension in a clean test tube. Test the suspension with glucose-sensitive tape, then with a few drops of Lugol's solution. Wash the test tube thoroughly and repeat the procedure with 5 ml of glucose solution.



✔ 10–1. How do you test for starch?

✔ 10–2. How do you test for sugar?

Now that you've seen how starch and sugar (glucose) test out, you're ready to investigate questions about enzymes.

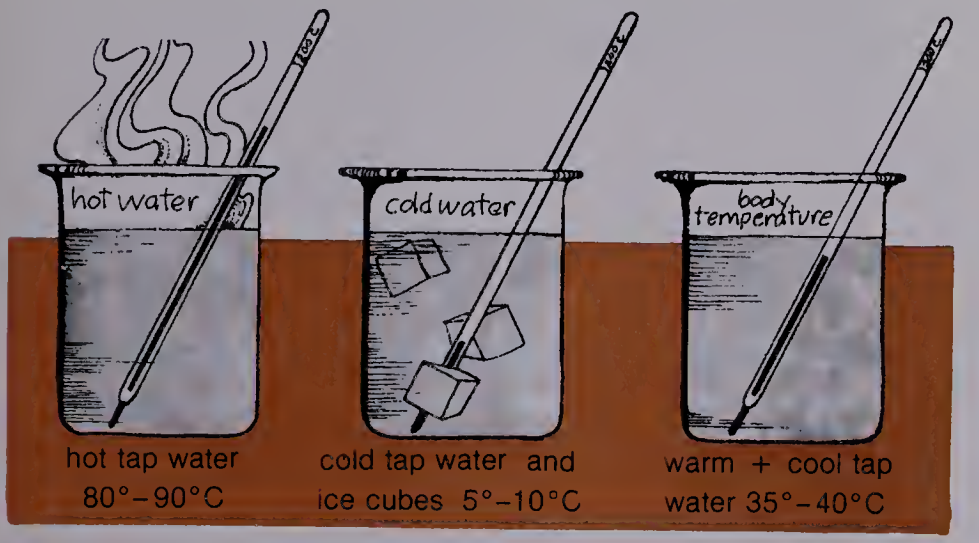
TEMPERATURE

★ **10–3. How does temperature influence enzyme activity?** (If you can answer this question and Question 10–8, you don't need to do the following investigation. Skip to Question 10–9.)

To find out whether temperature affects enzymes, you will need:

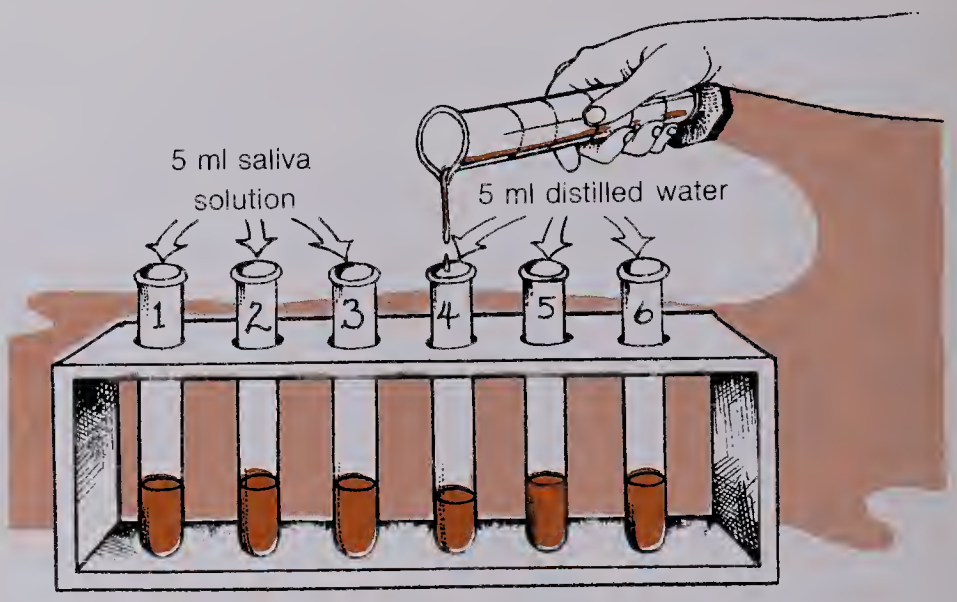
- a partner (if you wish)
- 3 beakers, 250-ml
- grease pencil for labeling
- thermometer, Celsius
- ice cubes
- graduated cylinder
- starch suspension
- 7 test tubes
- stirring rod
- glucose-sensitive tape
- clean rubber band
- distilled water
- test-tube rack
- watch or clock with second hand

A. Label three breakers: *hot water, cold water,* and *body temperature.* Fill the beakers ¾ full according to the directions in the illustration.

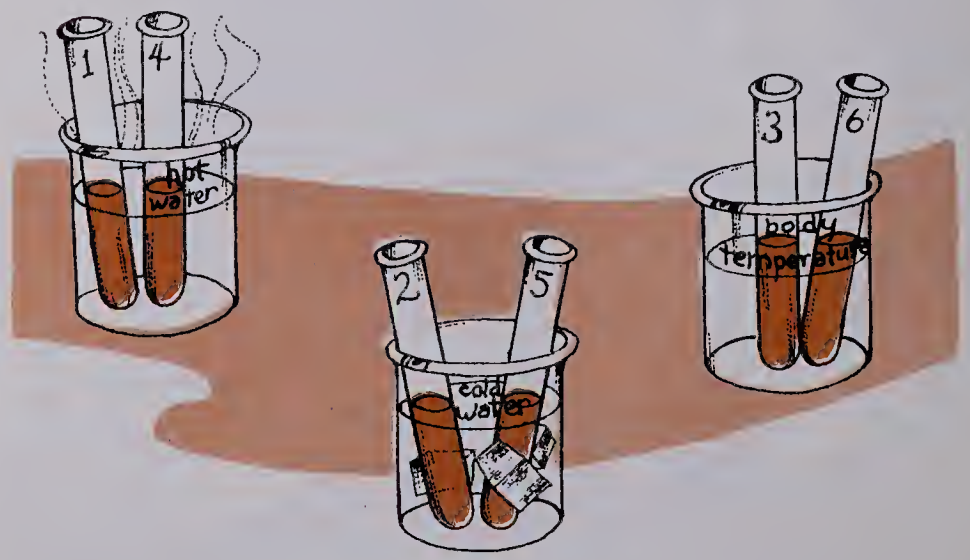


B. Chew on a clean rubber band to produce saliva. Collect 7 or 8 ml of saliva in a clean test tube. Then add enough distilled water to make 15 ml of saliva solution. Shake the test tube gently to mix the solution.

C. Label six clean test tubes from *1* to *6* and place them in a test-tube rack. Add 5 ml of starch suspension to each test tube. Then add 5 ml of saliva solution to Tubes 1, 2, and 3 only. Wash out the graduated cylinder and add 5 ml of distilled water to Tubes 4, 5, and 6 only.



D. Put Tubes 1 and 4 in the beaker of hot water; put Tubes 2 and 5 in the beaker of cold water; put Tubes 3 and 6 in the beaker of water at body temperature. Every 2 minutes for 20 minutes, use glucose-sensitive tape to test the contents of each tube for the presence of sugar. Record your observations in your notebook. You may want to use a table similar to the one shown in Figure 10–1.



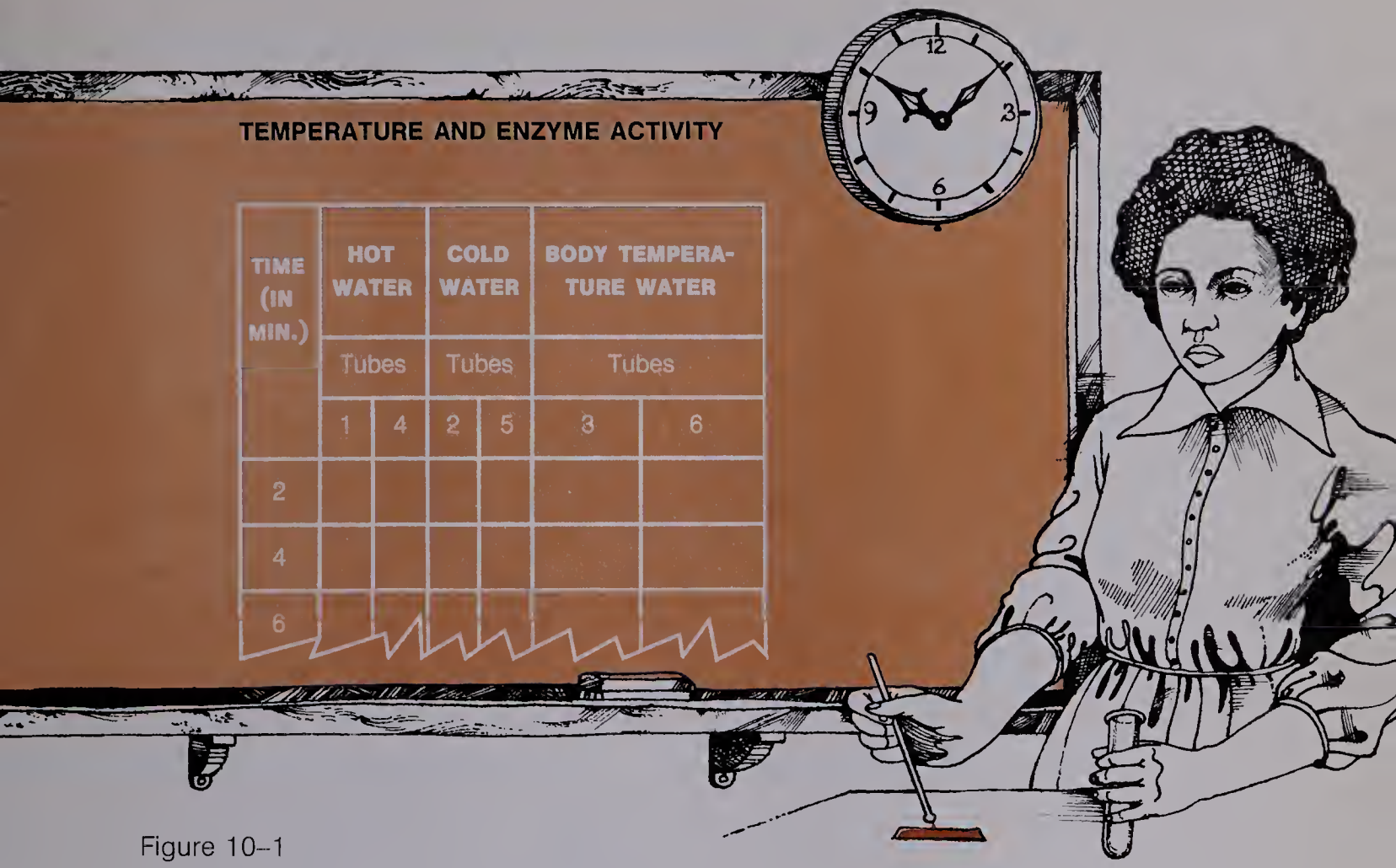


Figure 10–1

✔ 10–4. At which temperature did you get the first positive test for sugar? The last positive test?

✔ 10–5. At which temperature did the reaction go fastest?

✔ 10–6. Consider the setup of the investigation. How do you know that salivary amylase, rather than something in the distilled water or starch suspension, was responsible for the presence of sugar?

✔ 10–7. Do your data confirm that temperature has something to do with the rate of starch digestion? Explain your answer.

★ **10–8. Suppose you were stranded somewhere without shelter and the temperature dropped below freezing. How might your body's enzyme activity be changed?**

AMOUNT

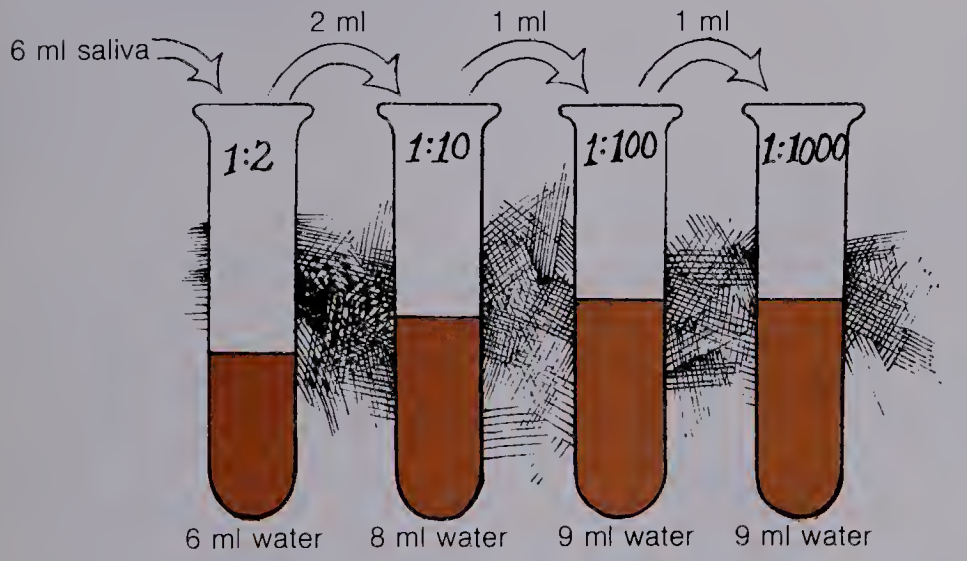
★ **10–9. What, if anything, does the amount of an enzyme have to do with the rate of a reaction?** (If you can answer this question and Question 10–13, skip to Question 10–14.)

To find out how the concentration of an enzyme influences the rate of a reaction, you will need the following:

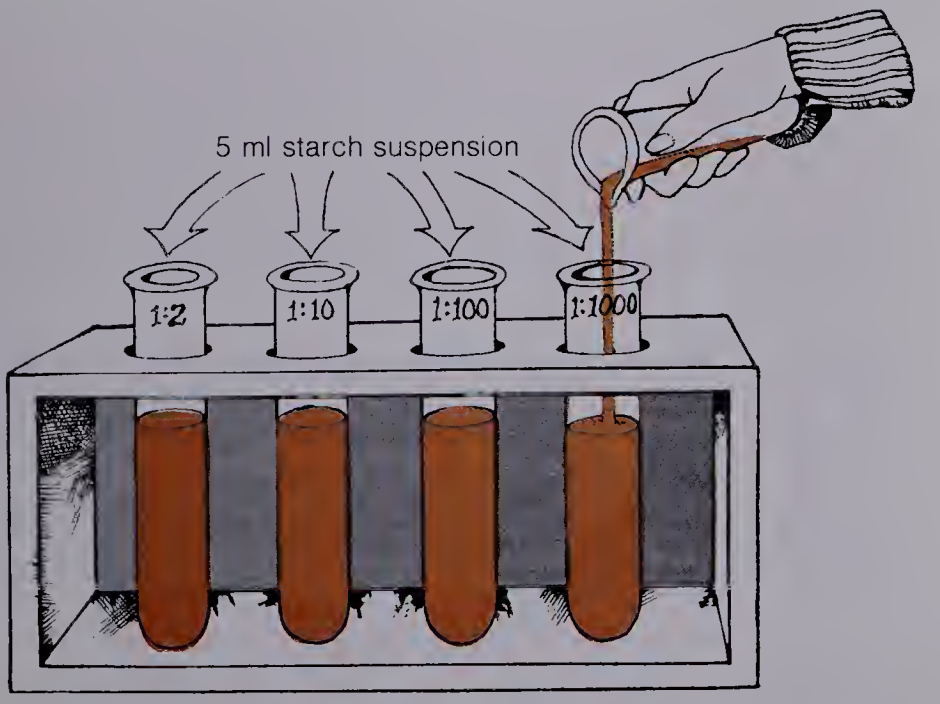
a partner (if you wish)	test-tube rack
5 test tubes	pipette
grease pencil for labeling	starch suspension
clean rubber band	stirring rod
graduated cylinder	glucose-sensitive tape
distilled water	watch or clock with second hand

A. Label a clean test tube *1:2*. Chew on a clean rubber band to produce saliva, and collect 6 ml of saliva in the tube. Add 6 ml of distilled water. This gives you a 1:2 dilution (one part saliva to two parts solution). Shake the tube well, then place it in a test-tube rack.

B. Label three more test tubes *1:10, 1:100,* and *1:1000.* To get the 1:10 dilution, use a pipette to transfer 2 ml of the 1:2 dilution into the 1:10 test tube. Add 8 ml of distilled water to get a 1:10 dilution. Get the 1:100 and 1:1000 dilutions by following the illustration's directions.



C. Add 5 ml of starch suspension to each of the four test tubes. Then, every 2 minutes for 20 minutes, use glucose-sensitive tape to test each tube for the presence of sugar. Record your data in a table similar to the one shown in Figure 10–2.



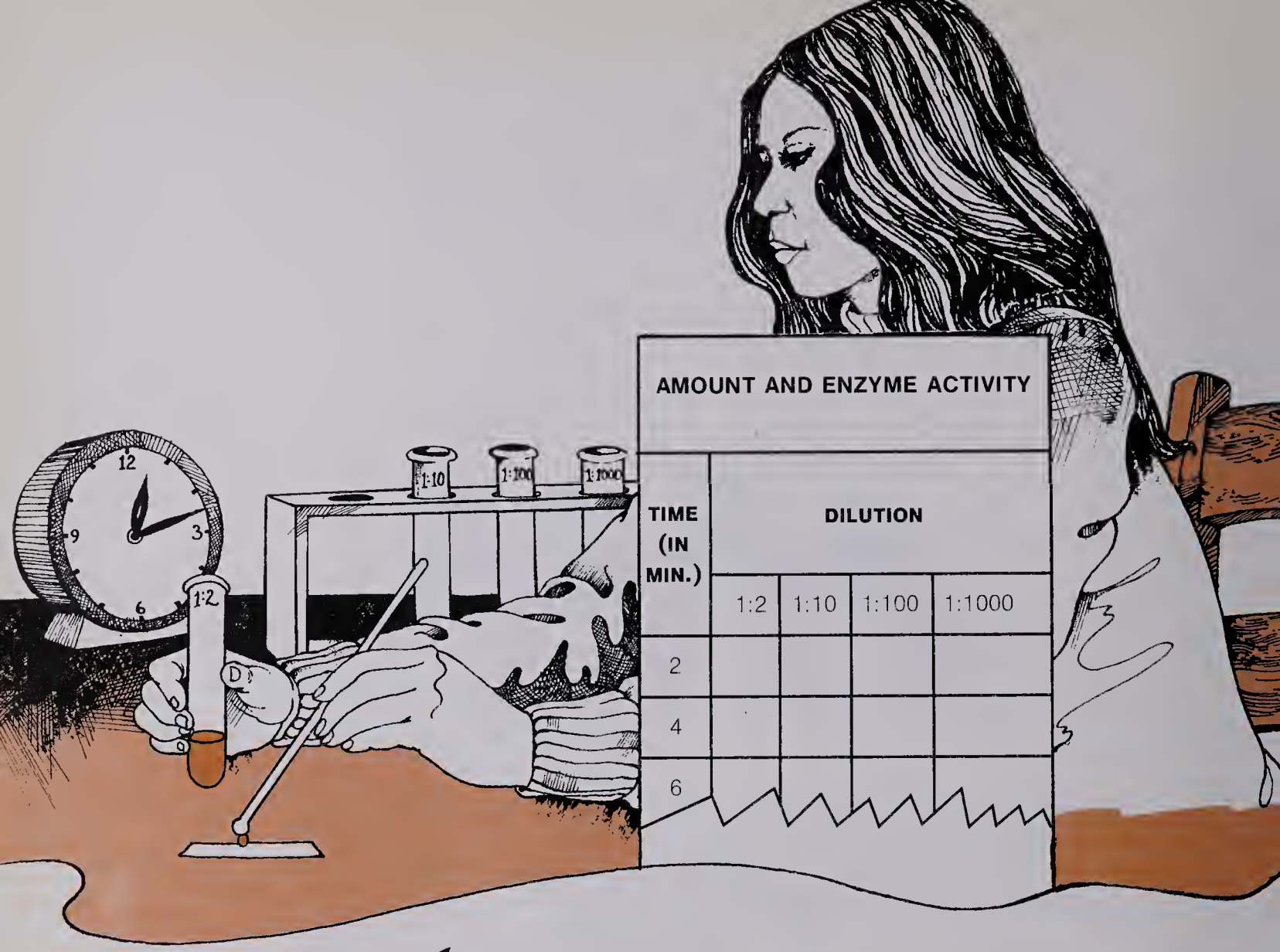


Figure 10–2

✓ 10–10. Which dilution first showed a positive test for sugar? Which dilution was last?

✓ 10–11. In which dilution did the reaction proceed most rapidly? Least rapidly?

★ **10–12. How does diluting the concentration of salivary amylase influence its ability to break down starch?**

✓ 10–13. Consider the setup of the investigation. How can you be sure that your results are due only to the diluting of saliva with distilled water?

FOOD SPECIFICITY

★ **10–14. How specific are enzymes?** (If you can answer this question and Question 10–17, skip to Question 10–18.)

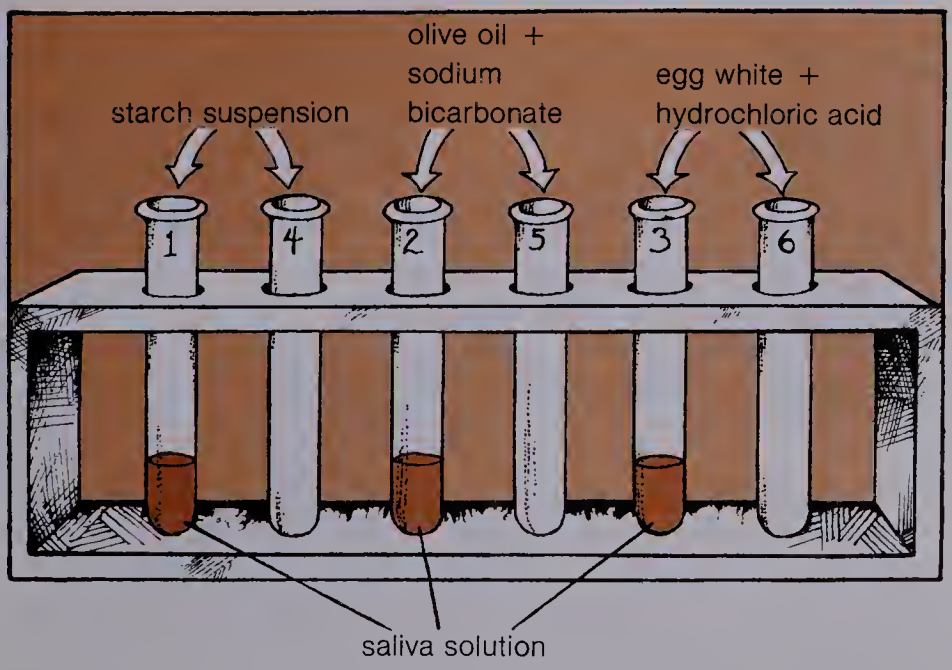
Will salivary amylase break down any foods besides starch? To find out, you will need the following:

a partner (if you wish)	medicine dropper
clean rubber band	sodium bicarbonate solution
7 test tubes	cooked egg white
graduated cylinder	dilute hydrochloric acid
distilled water	beaker, 250-ml
grease pencil for labeling	thermometer, Celsius
test-tube rack	stirring rod
starch suspension	glucose-sensitive tape
olive oil	watch or clock with second hand

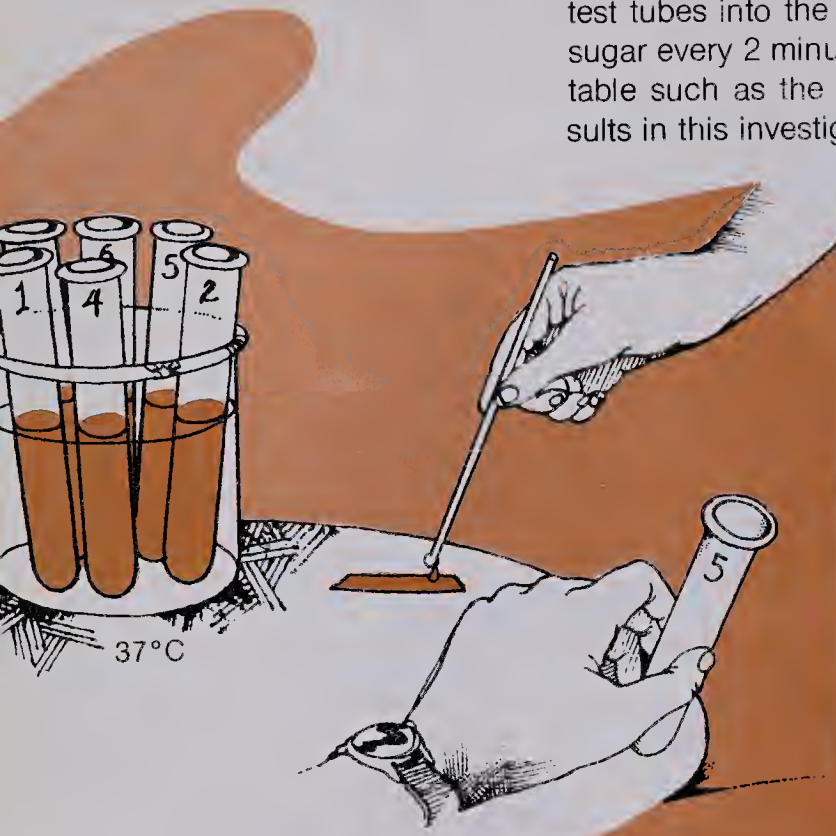
A. Chew on a clean rubber band to produce saliva. Collect about 7 or 8 ml in a clean test tube. Add enough distilled water to make 15 ml of saliva solution. Gently shake the test tube to mix the solution.

B. Label six clean test tubes from *1* to *6* and place them in a test-tube rack. Do the following to the test tubes. Be sure to wash out the graduated cylinder after each use.

1. To Tubes 1, 2, and 3, add 5 ml of saliva solution.
2. To Tubes 1 and 4, add 10 ml of starch suspension.
3. To Tubes 2 and 5, add 2 drops of olive oil *and* 10 ml of sodium bicarbonate solution.
4. To Tubes 3 and 6, add a pea-sized piece of cooked egg white *and* 10 ml of dilute hydrochloric acid.



C. Fill a beaker ¾ full with water at or near 37°C. Put the six test tubes into the beaker. Wait for 20 minutes, then test for sugar every 2 minutes for 10 minutes. You may wish to use a table such as the one in Figure 10–3 for recording your results in this investigation.



FOOD AND ENZYME ACTIVITY

TIME (IN MIN.)	STARCH		OLIVE OIL		EGG WHITE	
	Tubes		Tubes		Tubes	
	1	4	2	5	3	6
2						
4						
6						

Figure 10–3

✓ 10–15. In which test tube did the first positive test for sugar occur? Did the other tubes test positive for sugar later?

✓ 10–16. Does salivary amylase break down fats (olive oil)? Proteins (egg white)? Support your answers with evidence from the investigation.

★ **10–17. Design an experiment to show that the enzyme pepsin is specific for protein digestion.** (You may want to do the experiment if you have time.)

pH SPECIFICITY

★ **10–18. Enzymes are said to be pH specific. Is this true of salivary amylase?** (If you can answer this question and Question 10–22, skip to Question 10–23. If you don't know what pH means, see *Resource Unit 7* before doing the investigation.)

To find out if salivary amylase is pH specific, you will need the following:

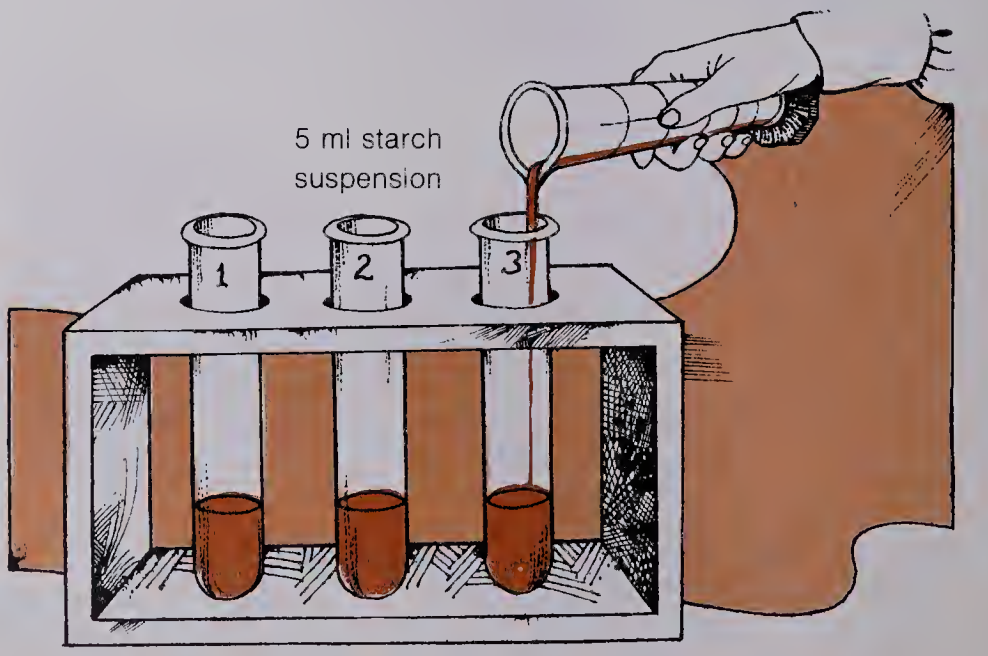
a partner (if you wish)
pH test paper and dispenser with color-code chart
clean rubber band
graduated cylinder
4 test tubes
grease pencil for labeling
test-tube rack
distilled water
starch suspension
dilute hydrochloric acid
dilute sodium hydroxide
beaker, 250-ml
thermometer, Celsius
stirring rod
glucose-sensitive tape
watch or clock with second hand

A. Wet a piece of pH paper on your tongue. Find the pH by using the color-code chart on the dispenser.

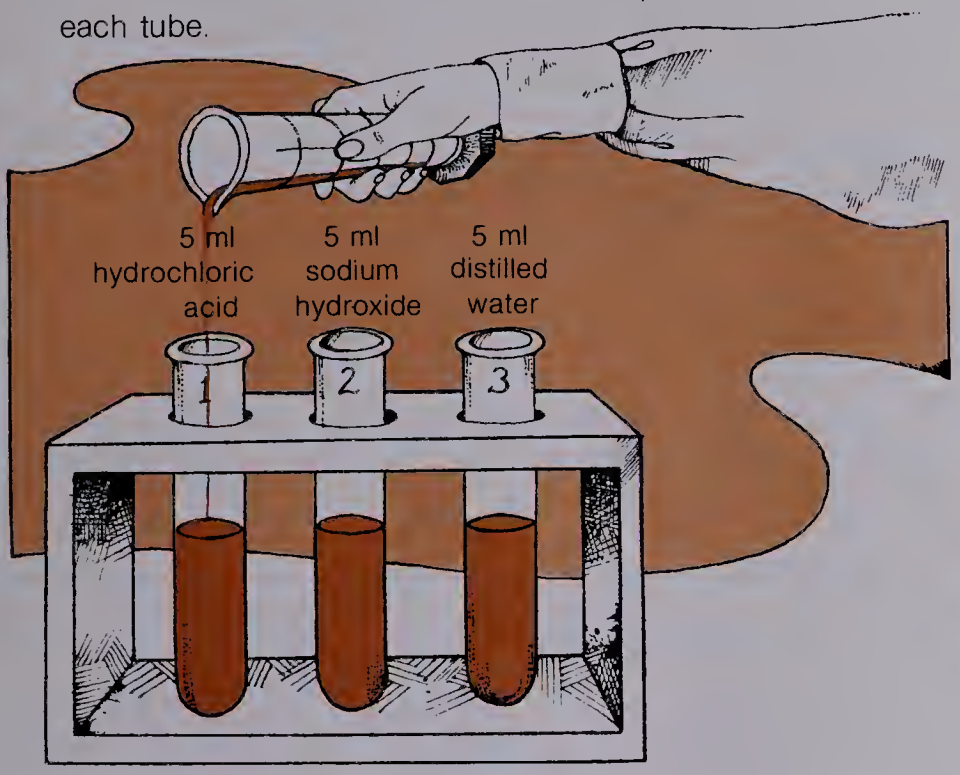
✓ 10–19. What is the pH of your mouth?

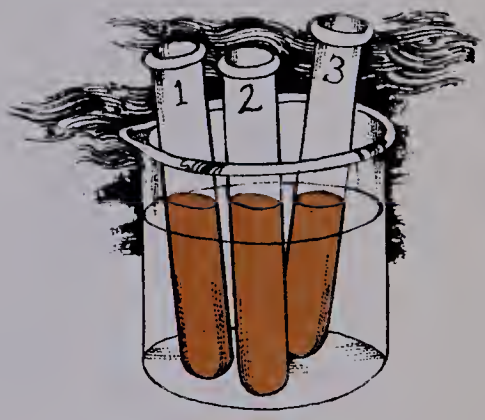
B. Chew on a clean rubber band to produce saliva. Collect about 7 or 8 ml in a clean test tube. Add enough distilled water to make 15 ml of saliva solution. Gently shake the test tube to mix the solution.

C. Label three clean test tubes from *1* to *3*. Into each test tube, put 5 ml of saliva solution and 5 ml of starch suspension.



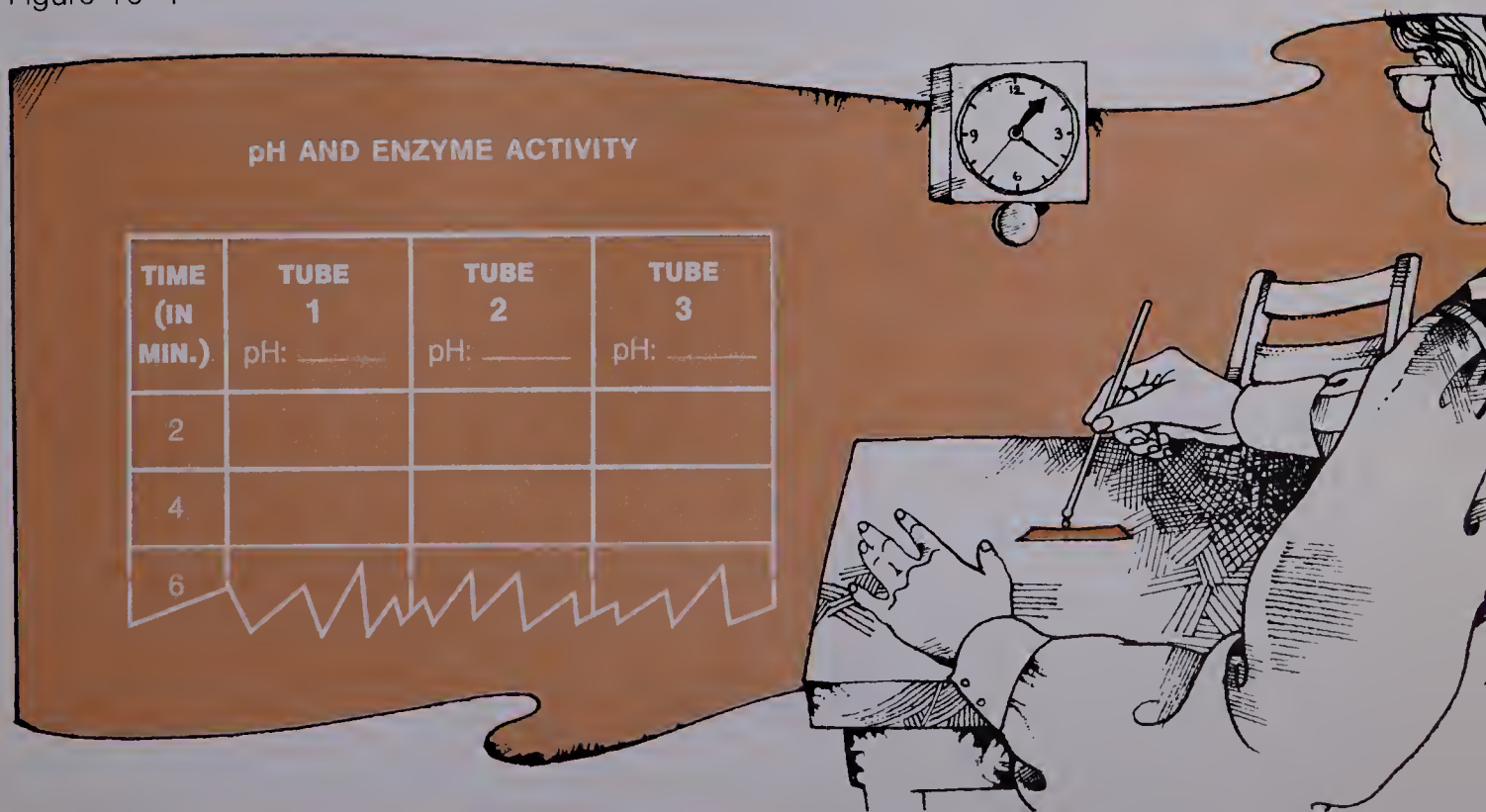
D. To Tube 1, add 5 ml of dilute hydrochloric acid. Don't forget to wash out the graduated cylinder after each use. To Tube 2, add 5 ml of dilute sodium hydroxide. To Tube 3, add 5 ml of distilled water. Find and record the pH of the solution in each tube.





E. Fill a beaker ¾ full of water at or near 37°C. Put the three tubes in the beaker. Wait 10 minutes, then test for sugar every 2 minutes for 10 minutes. Record your results in your notebook. You might use a table like the one in Figure 10–4.

Figure 10–4



✔ 10–20. In which test tube did the first positive test for sugar occur? Did the other tubes show a positive test later?

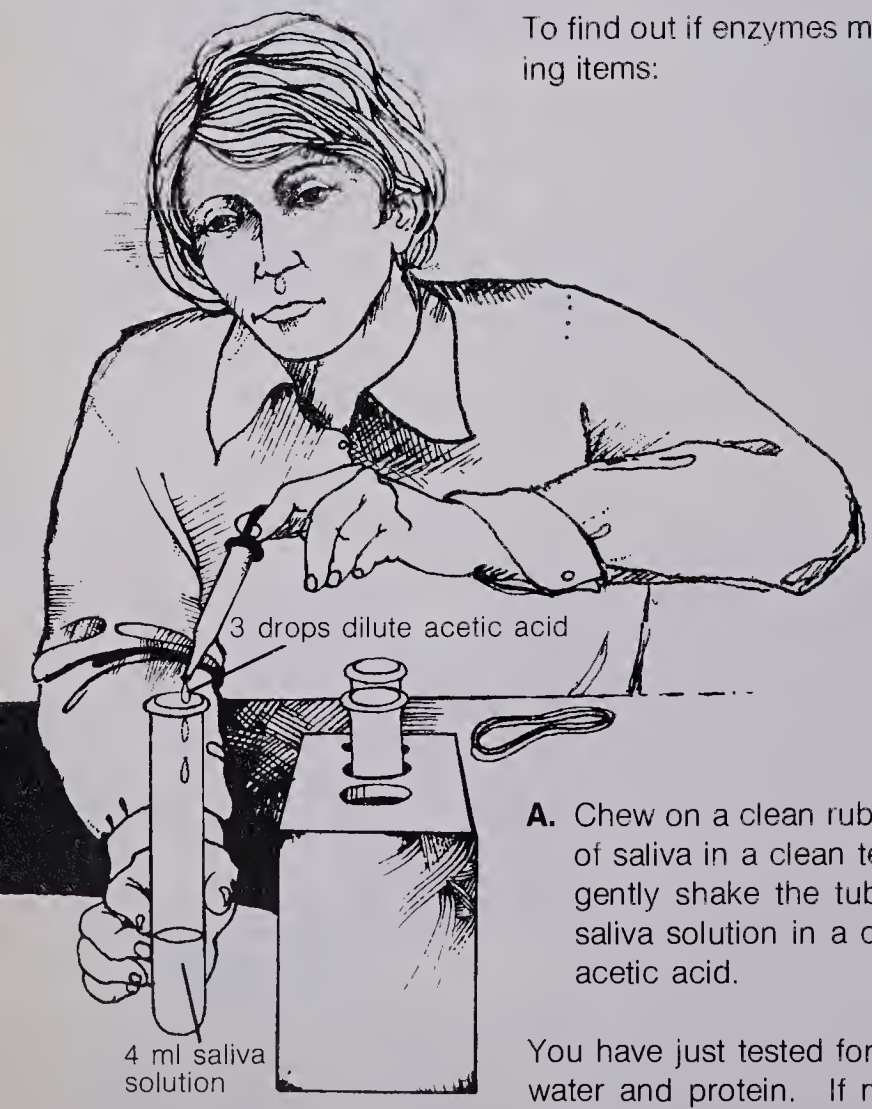
✔ 10–21. How does the pH of a solution influence the digestion of starch? Support your answer with evidence from the investigation.

✔ 10–22. Protein digestion in the stomach requires a pH of about 2. Is it possible for starch to be digested in the stomach? Explain.

MAKEUP

★ **10–23. What are enzymes made of?** (If you can answer this question and Question 10–27, you have finished the investigations in this activity.)

To find out if enzymes might be proteins, you will need the following items:



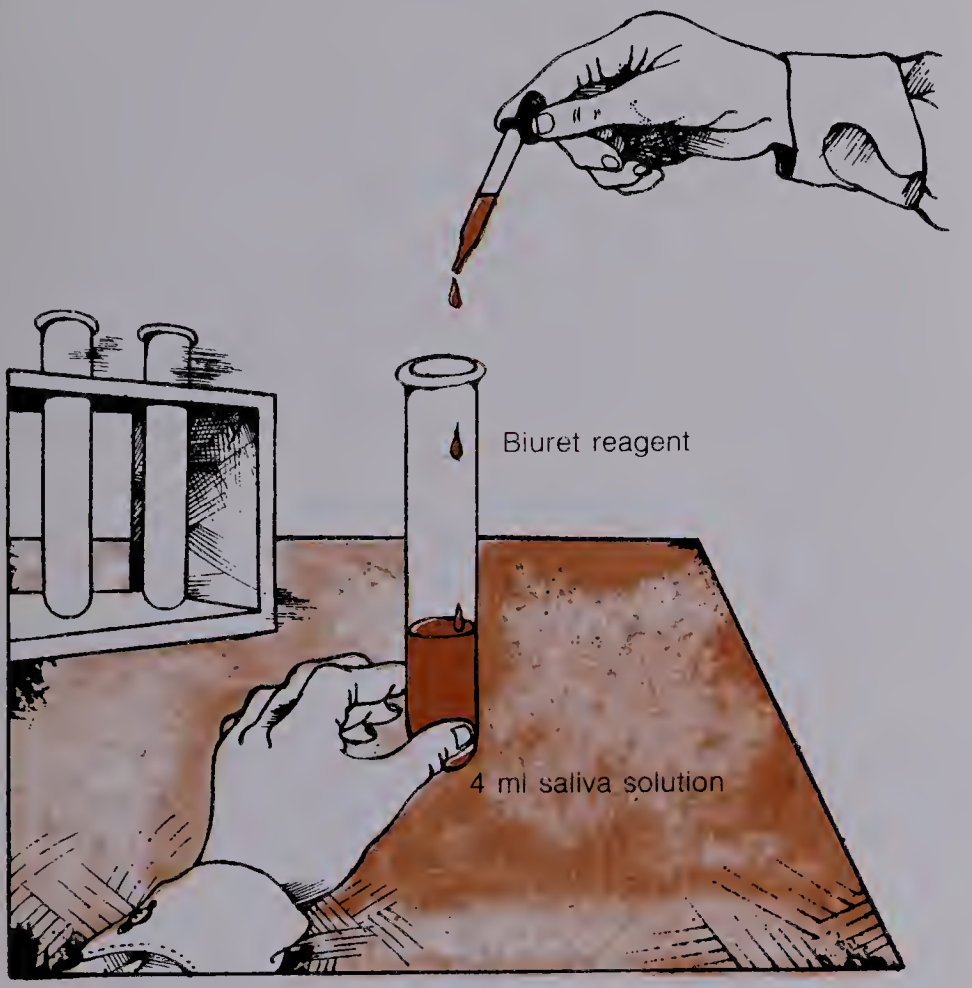
a partner (if you wish)
clean rubber band
3 test tubes
distilled water
test-tube rack
graduated cylinder
dilute acetic acid
medicine dropper
Biuret reagent

A. Chew on a clean rubber band to produce saliva. Collect 4 ml of saliva in a clean test tube. Add 4 ml of distilled water and gently shake the tube to mix the solution. Put 4 ml of the saliva solution in a clean test tube and add 3 drops of dilute acetic acid.

You have just tested for the presence of mucus, which is mostly water and protein. If mucus is present, the saliva gets lumpy.

✔ 10–24. Is mucus present in your saliva?

B. Put 4 ml of saliva solution in a clean test tube. Add Biuret reagent, drop by drop, until there is a color change.



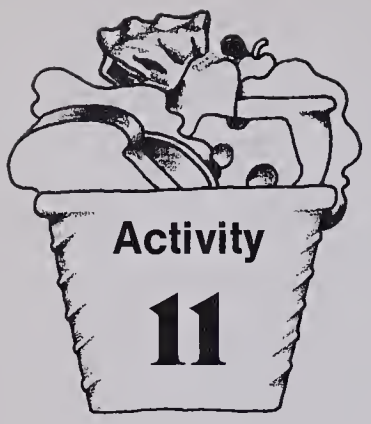
If the solution became a violet or pink-violet color, you got a positive test for protein.

✔ 10–25. Is protein present in your saliva?

So, what do you have? You know that mucus is mostly water and protein. You know that your saliva contains an enzyme. But do you have any evidence that enzymes are proteins?

✔ 10–26. Why isn't the investigation you just did proof that enzymes are proteins?

✔ 10–27. Suppose the enzyme were the only substance in saliva other than water. Would that prove it was a protein?



Gut Reactions Specialists

During digestion, food substances are broken down by a chemical process called *hydrolysis* [high-DROLL-i-sis]. The prefix *hydro-* refers to water. In hydrolysis, large food substances are split into subunits by the addition of water. Like most reactions in the body, hydrolysis is dependent on the action of enzymes.

The hydrolysis of starch is brought about by *amylase* [AM-i-lays] enzymes. The amylase in saliva, or salivary amylase, begins the digestion of starch in the mouth. Starch is actually a long chain of glucose molecules. Salivary amylase breaks down starch by breaking some of the bonds that chain the glucose molecules together.

The glucose molecules are separated from the starch in twos (see Figure 11–1). The freed ends of the paired glucose molecules attract parts of water (H_2O) molecules from the saliva. Molecules of the sugar maltose, chains of two glucose molecules, are formed.

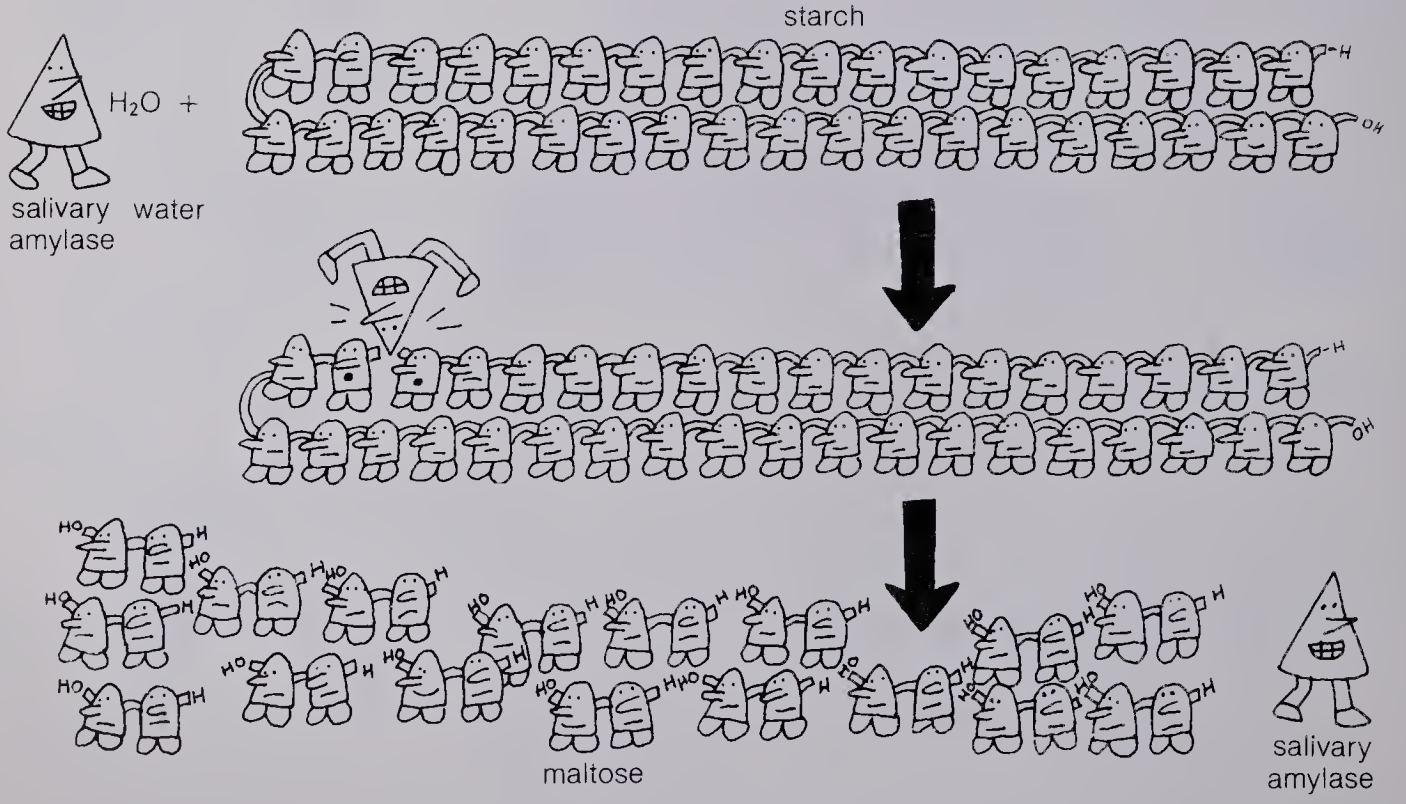


Figure 11–1

✔ 11–1. What is formed from the reaction shown in Figure 11–1?

An important characteristic of enzymes is shown in Figure 11–1. They make reactions occur without themselves being used up or changed. Enzymes are also very specific—they're specialists! Salivary amylase, for instance, can break bonds within starch molecules only. It has no effect on fats and proteins.

Amylase is also specific to its surroundings, unable to work in an acid environment such as the stomach. For this reason, no starch digestion occurs in the stomach. But starch is still present because the food didn't stay in the mouth long enough for the salivary amylase to finish its job. So in the small intestine, an amylase from the pancreas continues the breakdown of starch to maltose.

It remains now for the maltose molecules to be broken down into glucose molecules (Figure 11–2). Still in the small intestine, the enzyme *maltase* completes the digestion of starch by breaking down maltose. Again, parts of water molecules attach to the freed ends of the new molecules.

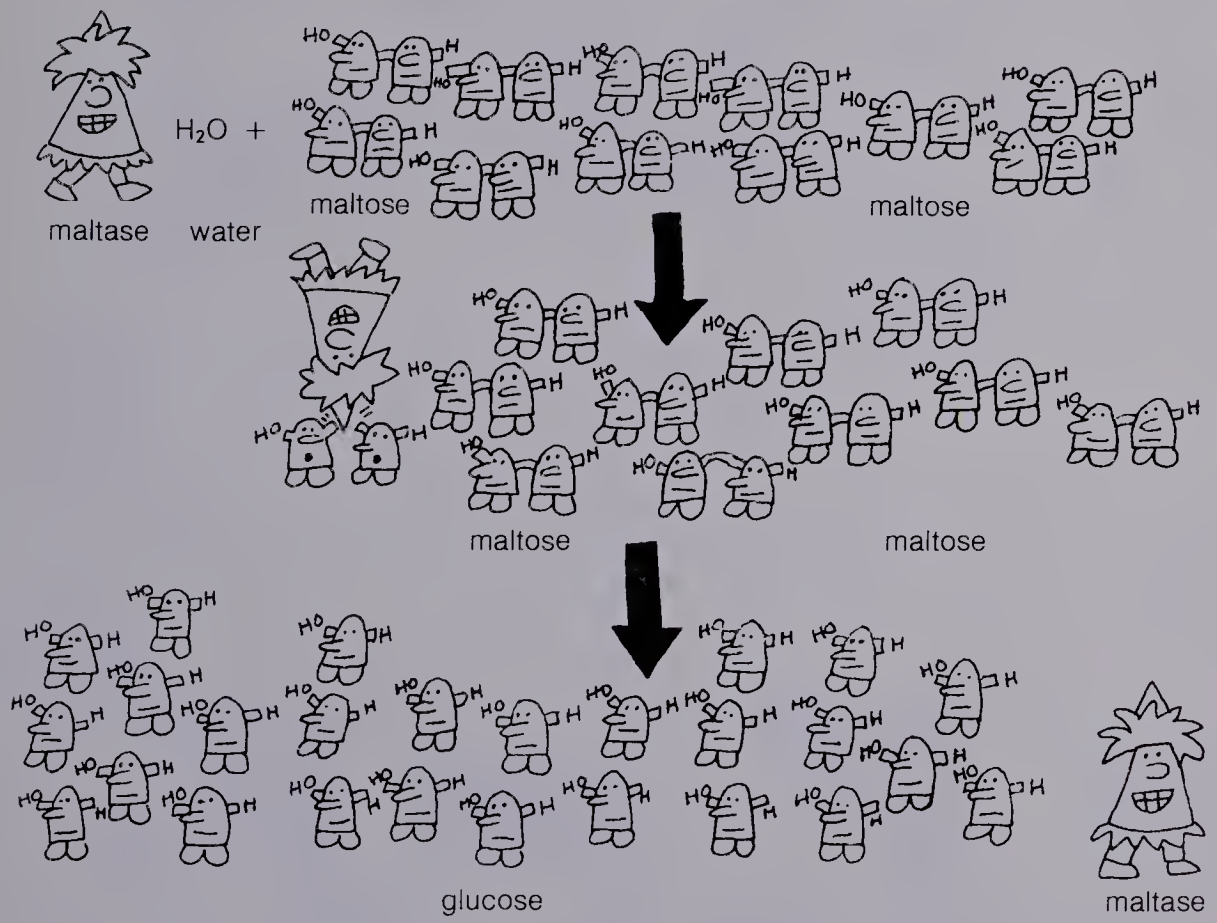


Figure 11–2

✔ 11–2. What is formed from the reaction shown in Figure 11–2?

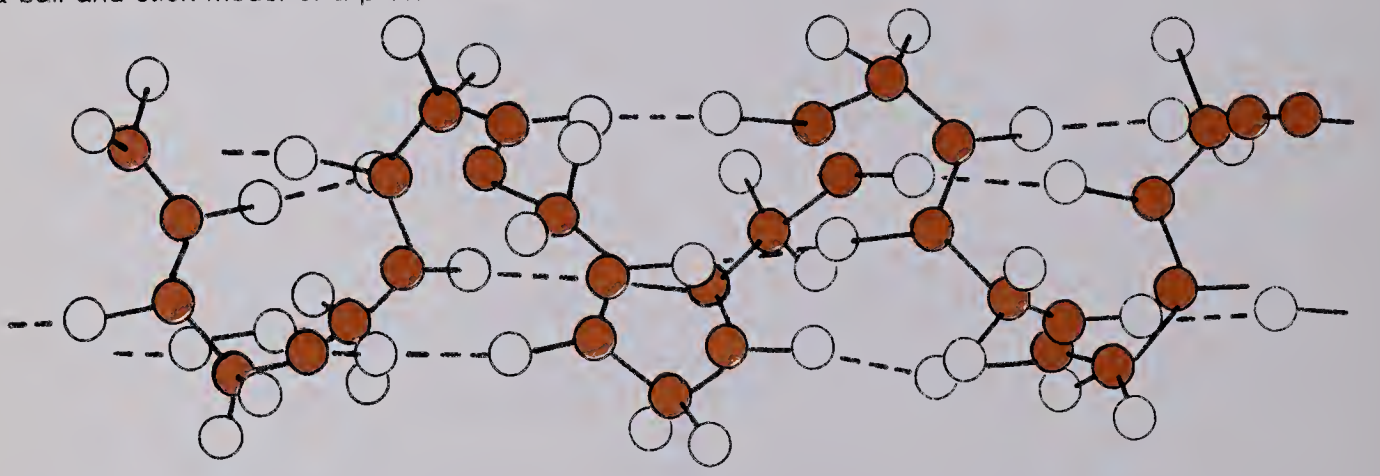
The process of starch digestion can be shown as follows:

$$\text{starch} + \text{water} \xrightarrow{\text{amylase}} \text{maltose} + \text{water} \xrightarrow{\text{maltase}} \text{glucose}$$

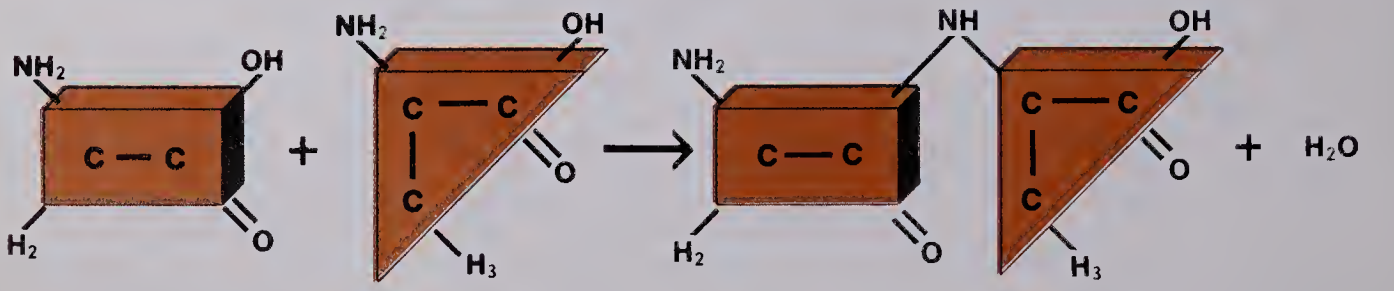
The glucose can be absorbed through the villi and taken up by the bloodstream for transport to the body's cells. There, most of the glucose is used to provide energy.

★ **11–3. Describe in your own words how starch is completely digested in the body.**

a ball and stick model of a protein molecule



Proteins, like starch, are very large molecules. But where starch consists of glucose subunits, proteins consist of *amino acid* subunits. There are about twenty different kinds of amino acids. The differences are in the number of carbon, oxygen, and hydrogen atoms and in the arrangements of those atoms. But what makes them all amino acids is that they each have an amino part *(NH_2)* and an acid part *(COOH)*.

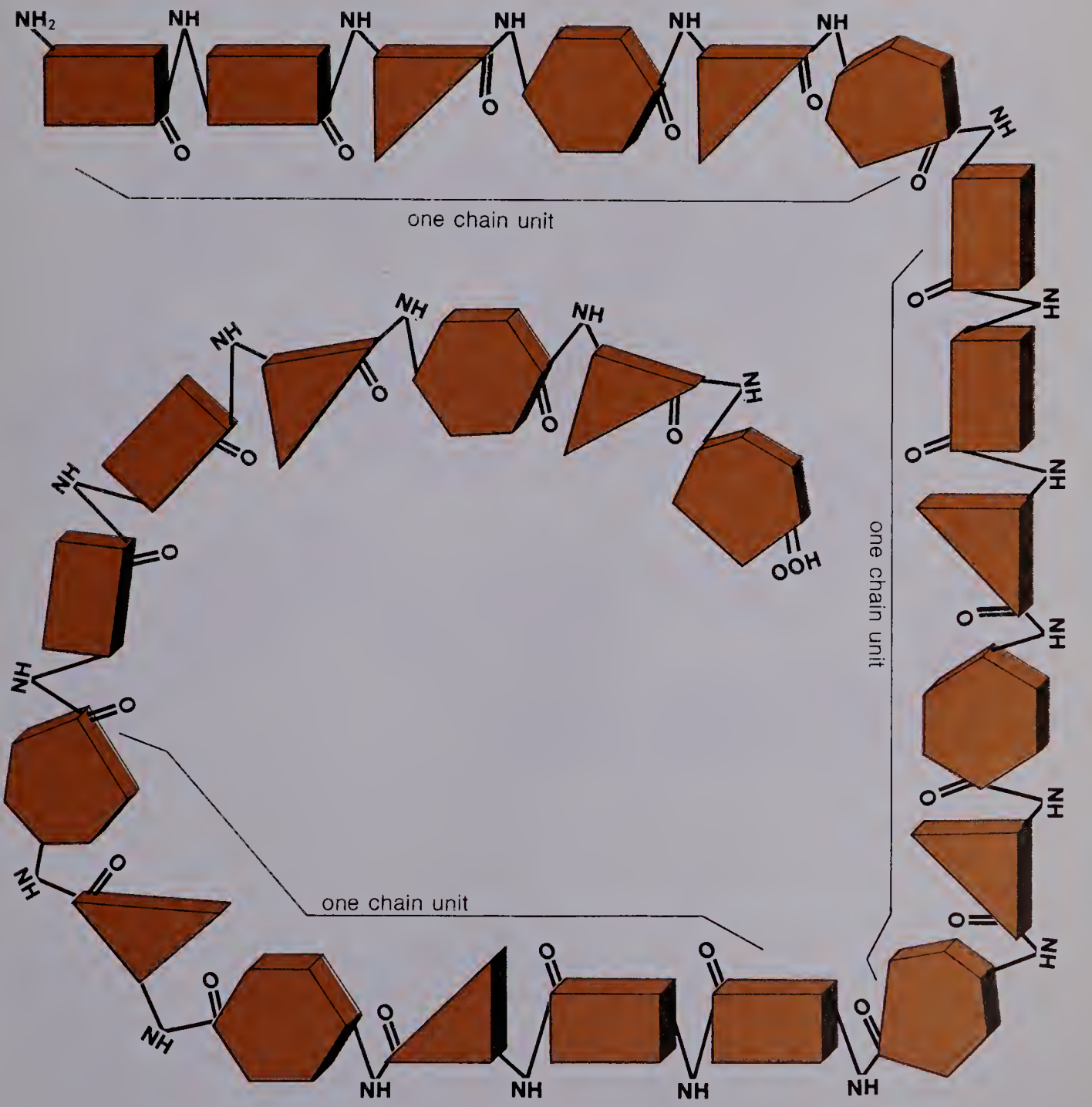


Amino Acid 1 + Amino Acid 2 ⟶ linked amino acids + water

Figure 11–3

As shown in Figure 11–3, the joining of two amino acids results in the formation of water. Water is released whenever amino acids bond together.

As the amino acids link up, they form chains. Their exact arrangement in a chain determines the kind of protein being formed. Each protein consists of repeating chain units and contains thousands of amino acids.



Unlike starch molecules, the breakdown of large protein molecules requires an acid environment. Protein digestion, therefore, doesn't begin until food gets to the stomach, where hydrochloric acid is present. As well as providing a favorable environment, the hydrochloric acid is also necessary to activate the enzyme that breaks down proteins.

An inactive form of the enzyme *pepsin* is secreted by cells lining the stomach walls. Hydrochloric acid changes the inactive form to the active form. Through hydrolysis, pepsin breaks proteins down into their chain units.

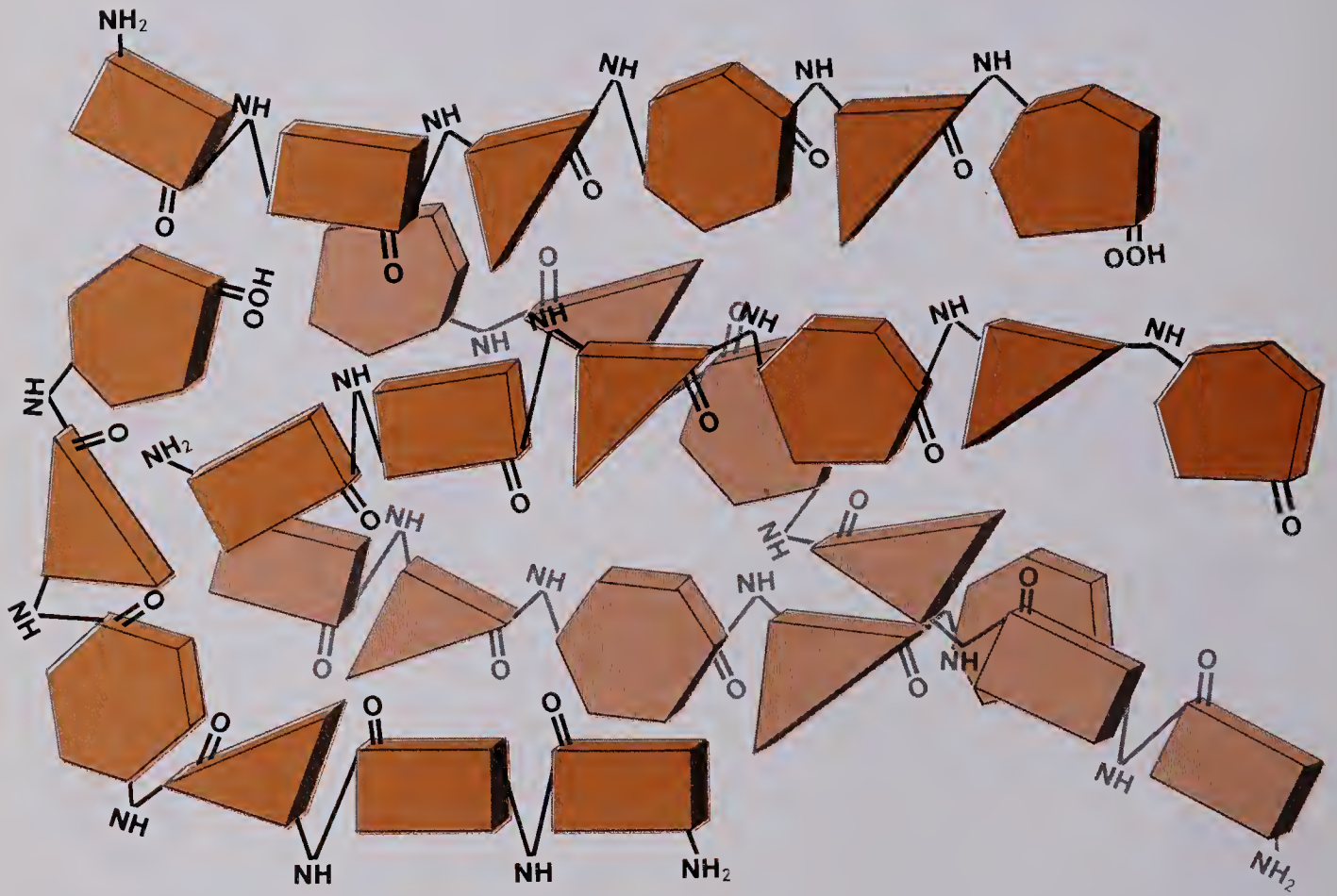


Figure 11–4

★ **11–4. Describe the process of protein digestion in the stomach. What are the products of this digestive reaction?**

Further digestion is necessary in the small intestine to release the individual amino acids from the chain units. This happens in an alkaline environment. Look at Figure 11–5.

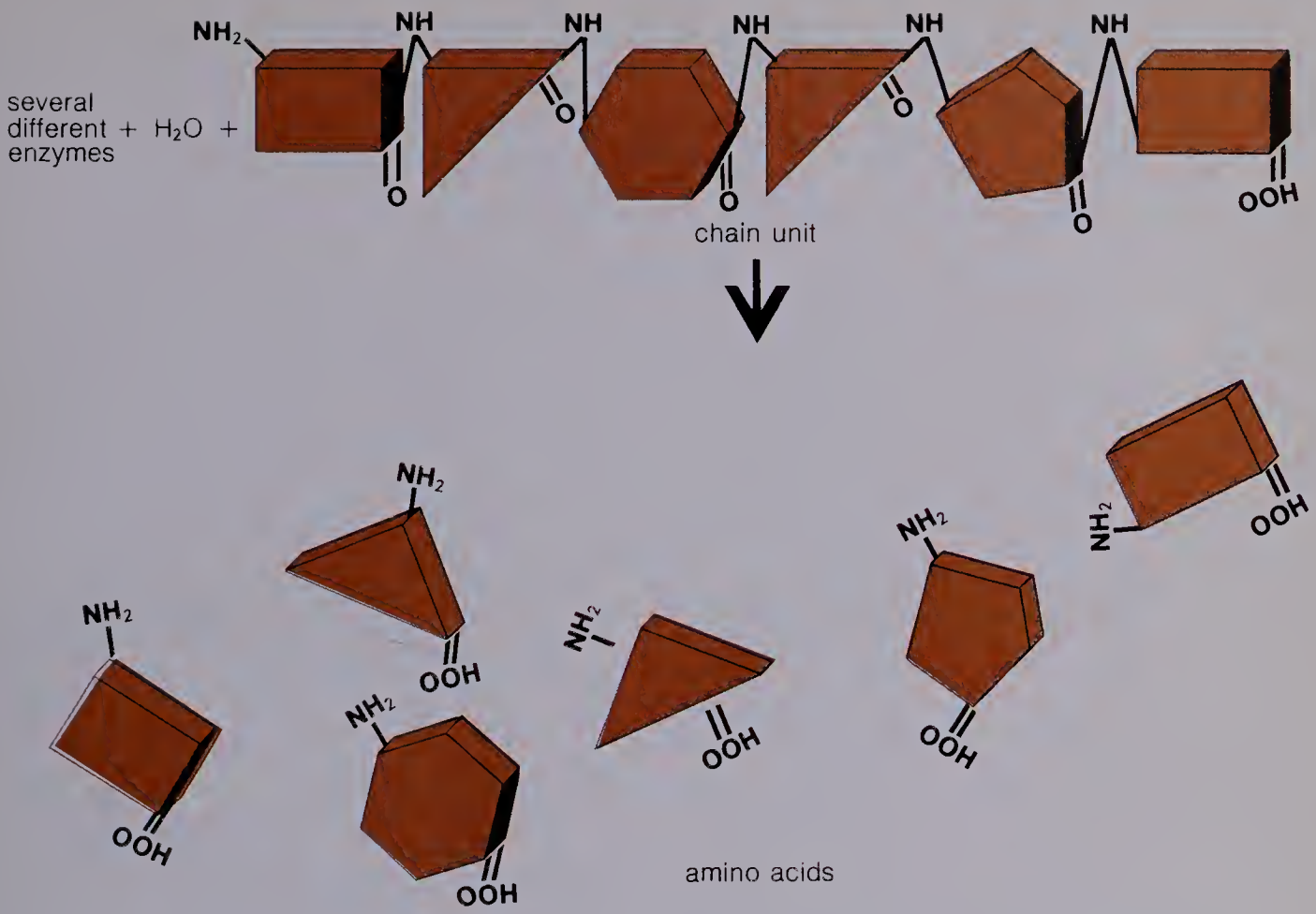


Figure 11–5

✓ 11–5. What must be present to release amino acids from the chain units?

As mentioned before, enzymes are specialists. Each enzyme hydrolyzes bonds in a specific chemical environment and will do so in no other environment. So, to complete protein digestion in the small intestine, enzymes other than pepsin are needed. And why several different enzymes? Because some will hydrolyze bonds only at the ends of chains while others hydrolyze the bonds within.

Through the combined action of enzymes, then, a protein is digested into fragments of various lengths and finally into free amino acids. The free amino acids can be absorbed through the walls of the intestine. Inside the body, the amino acids are rejoined into proteins that can be used by the body. This includes the making of enzymes, which happen to be proteins.

★ **11–6. What does the statement "enzymes are specialists" mean?**

excursion

Activity 12 Planning

Gone Tomorrow?

Activity 13 Page 63

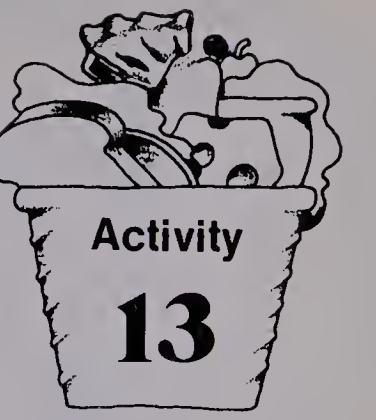
Do you, like most people, get cavities? Have you ever wondered why? Find out why in this activity, and learn what weapons you have against tooth decay.

Comparing Guts

Activity 14 Page 71

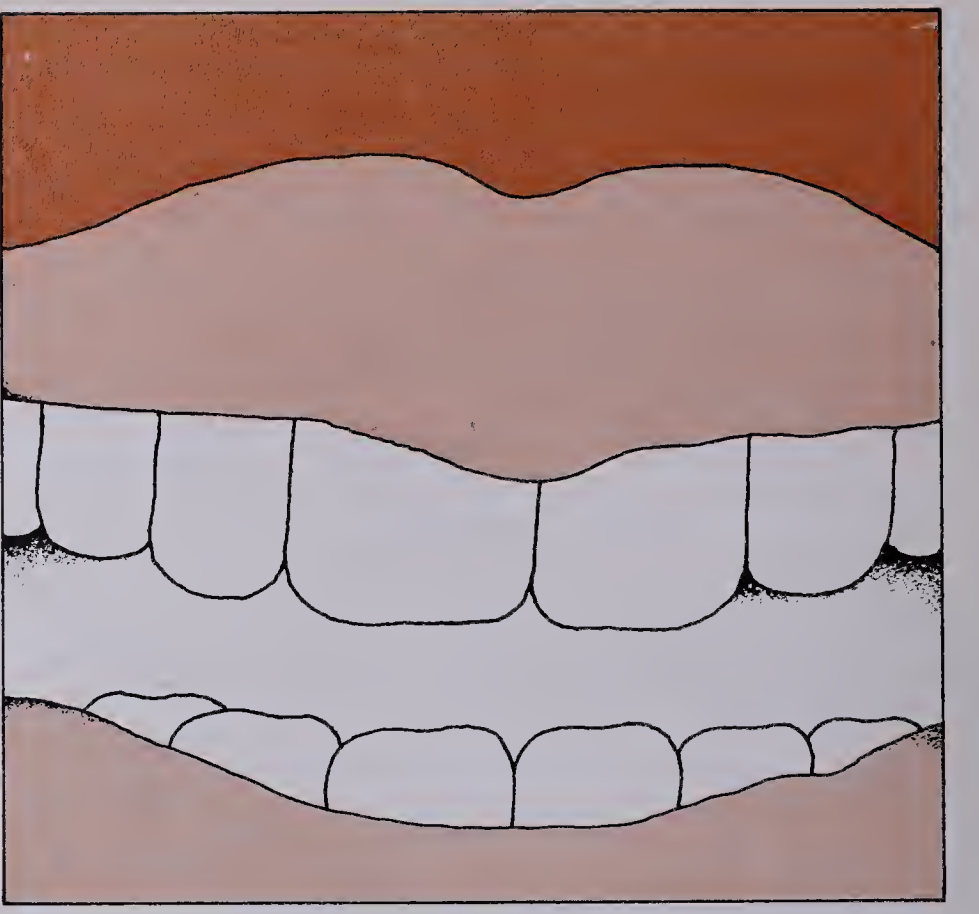
By examining a dissected frog, crayfish, earthworm, and pig, you can learn a lot about yourself. Give it a try—it's not so bad once you start.

Gone Tomorrow?

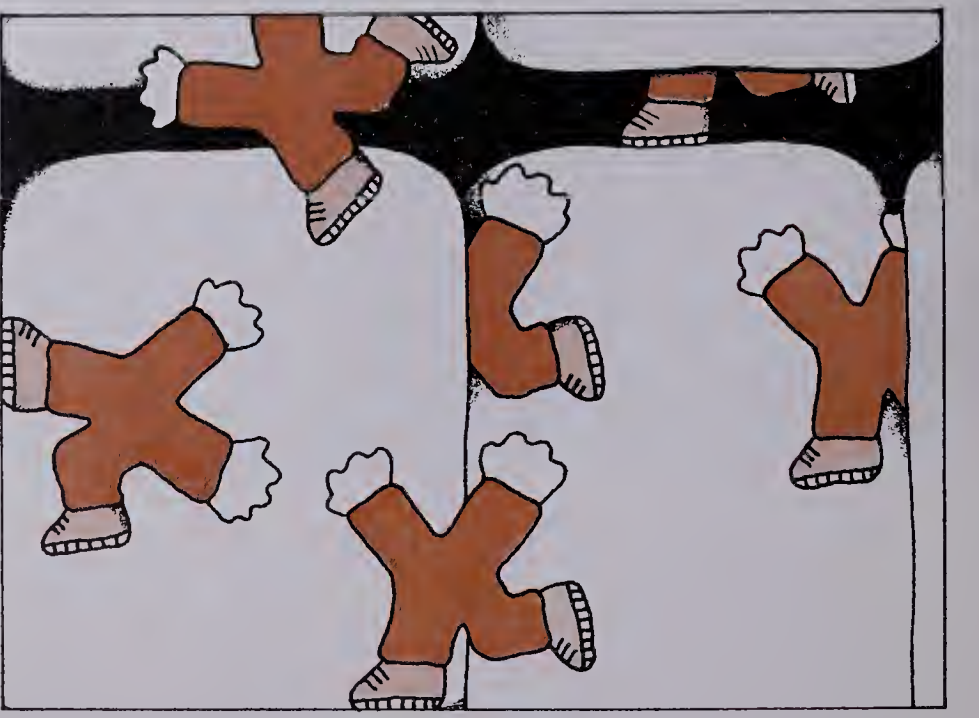


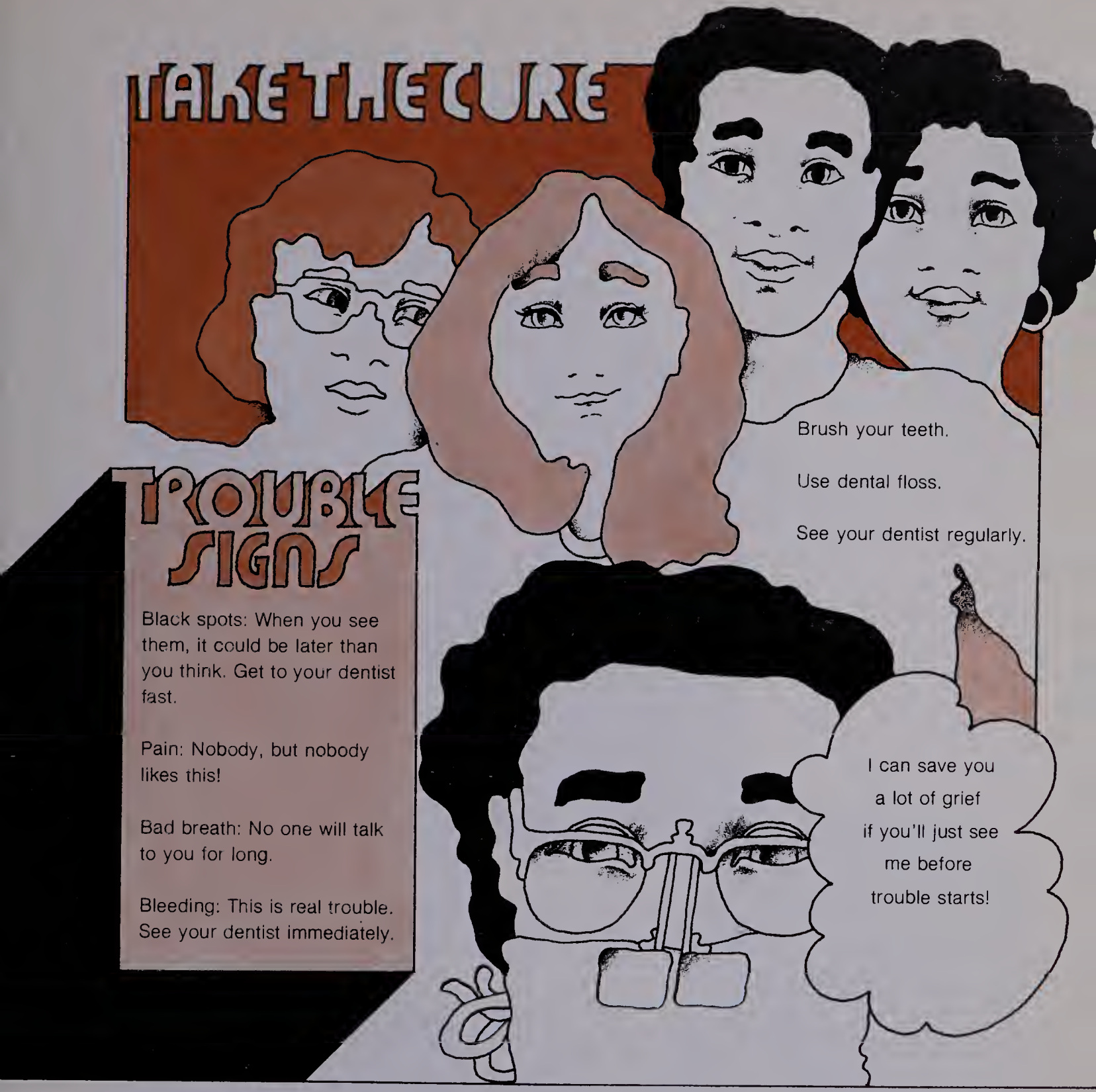
Have you ever seen people with some or all of their teeth missing? How does it happen? Could it happen to you?

Well, when you've had a snack, like a sandwich and a "tall cool one," bacteria like it too. They attach themselves to your teeth and combine with juices in your mouth. This combination of bacteria and juices forms a sticky, colorless film called *plaque* [PLACK].



Some of the bacteria in plaque act on the sugary part of your snack. The actions of those bacteria produce acids that can dissolve the enamel, or the protective covering, of your teeth.





Bacteria don't attack teeth, but the acids produced by the bacteria do. Acids are produced when the bacteria feed on the food around the teeth—food stuck in the grooves on teeth and food stuck between the teeth and the gums. Plaque contains bits of food, bacteria, bacterial acids, and saliva.

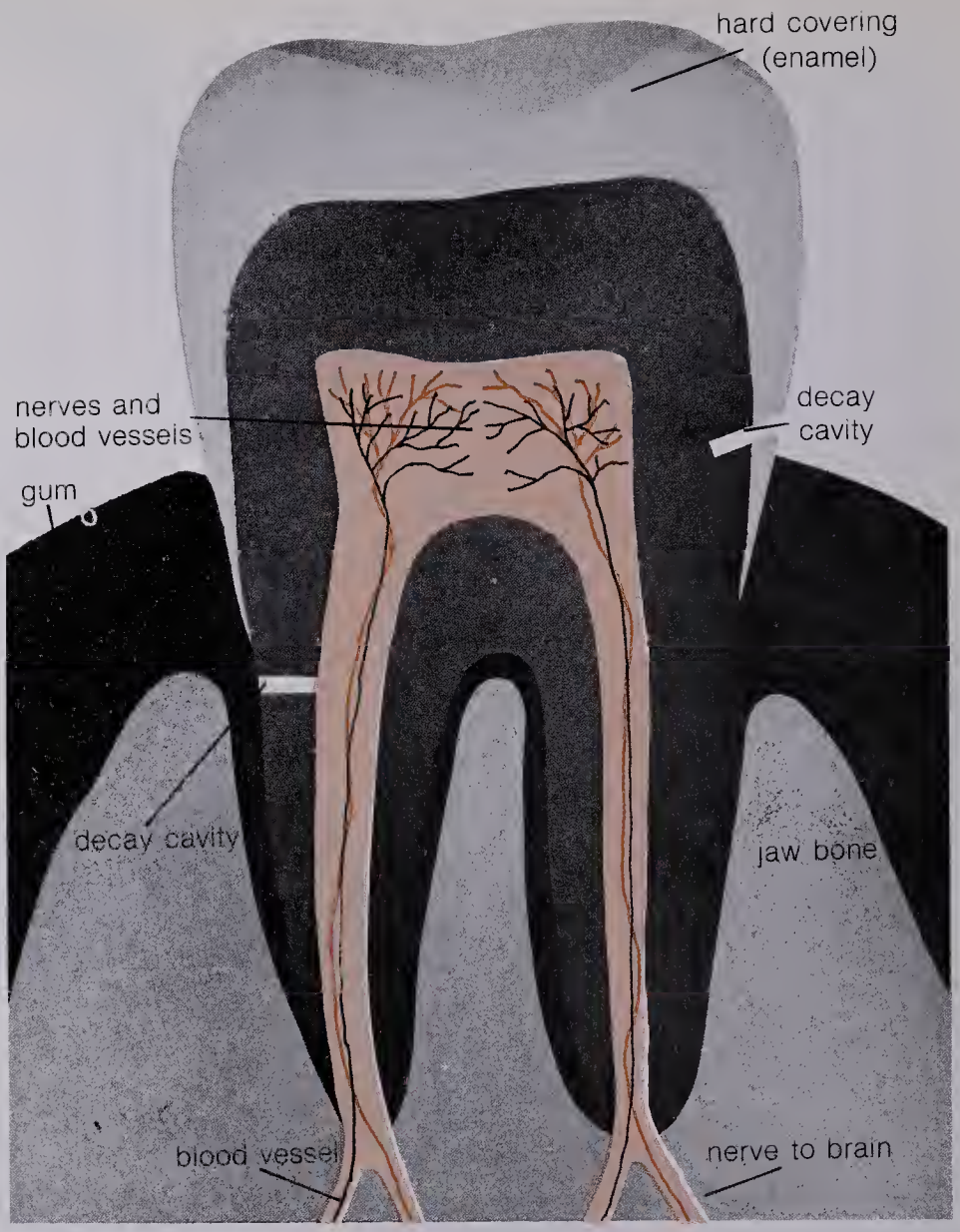


Figure 13–1

★ 13–1. What is plaque? How can it harm your teeth?

The enamel on your teeth is very strong, but not strong enough to resist the acids in plaque. There might not be much acid in your mouth right now. It all depends on how long ago you brushed your teeth or ate or drank something.

Some foods increase the amount of acid in your mouth. To see this, you will need the following materials:

pH test paper and dispenser with color-code chart
spoon
granulated sugar

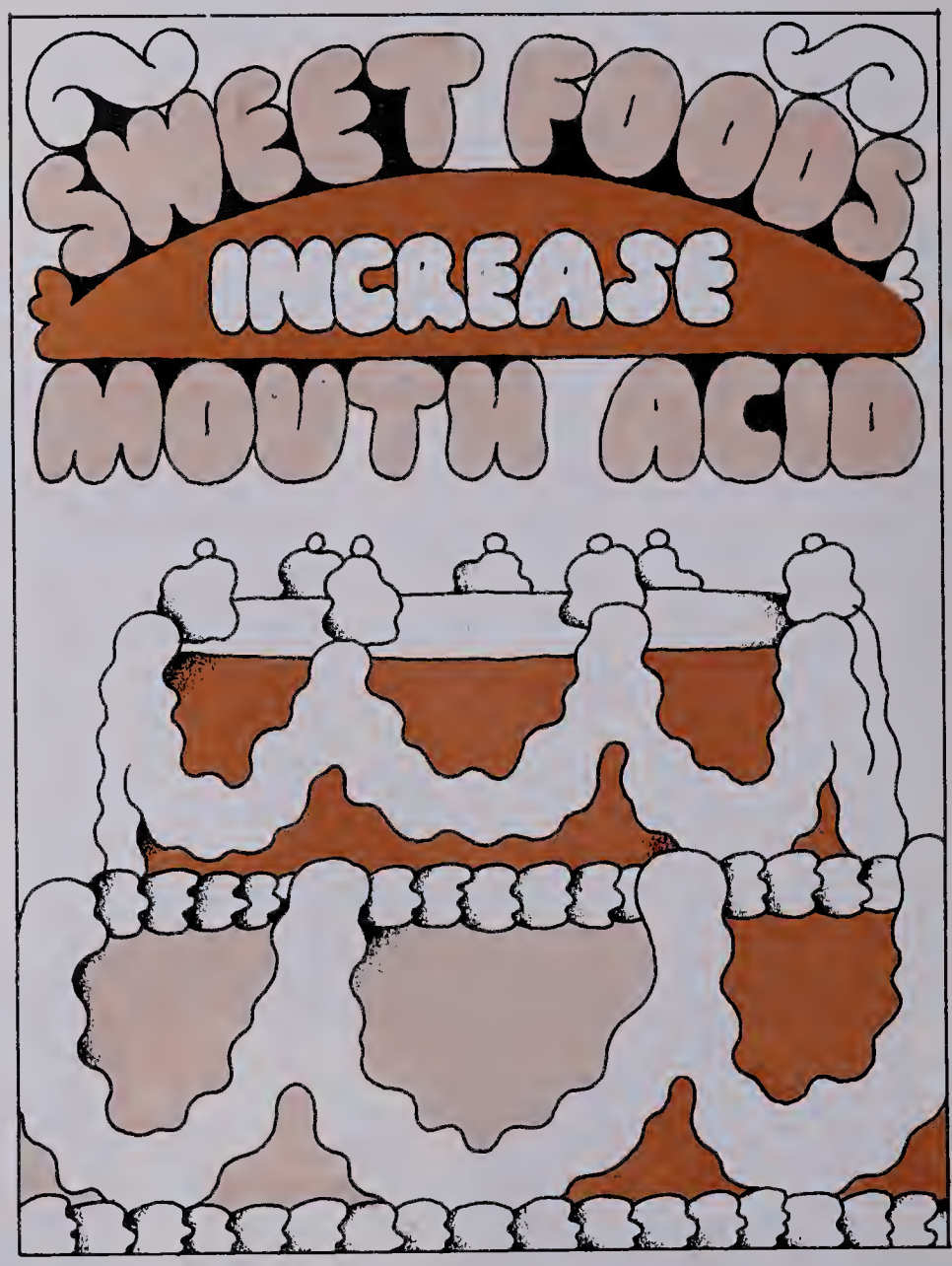
A. Touch a piece of pH paper, about 2 cm long, to a moist section of your mouth. Compare the color of the pH paper with the color chart on the dispenser.

✓ 13–2. What is the pH of your mouth? (If you don't understand pH, see *Resource Unit 7.*)

B. Put some sugar in your mouth and let it dissolve there before you swallow it. Wait a few minutes, then find the pH of your mouth.

✔ 13–3. What is the pH of your mouth after eating sugar?

Saliva helps keep your mouth at a neutral pH, or about 7, but--



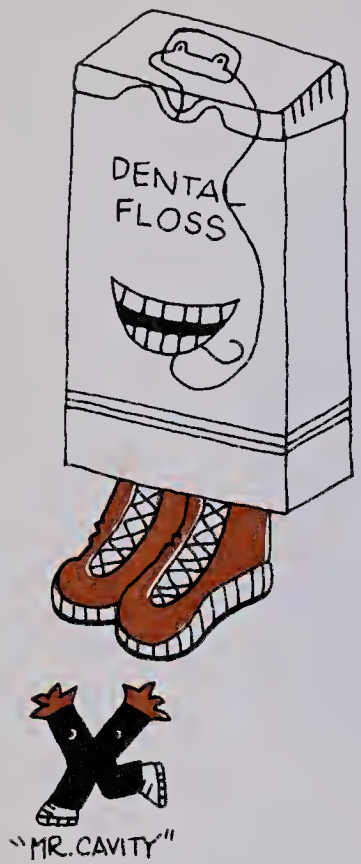
Acids eat away at your teeth. And bacteria in plaque produce the acids. To see how much plaque you have on your teeth, you will need the following items:

plaque-disclosing tablet
mirror
your own toothbrush
toothpaste

A. Chew a plaque-disclosing tablet and swish the solution between your teeth. Then rinse out your mouth and examine your teeth in a mirror.

✓ 13–4. Where is most of the plaque on your teeth?

B. Brush your teeth, especially where there is red dye.



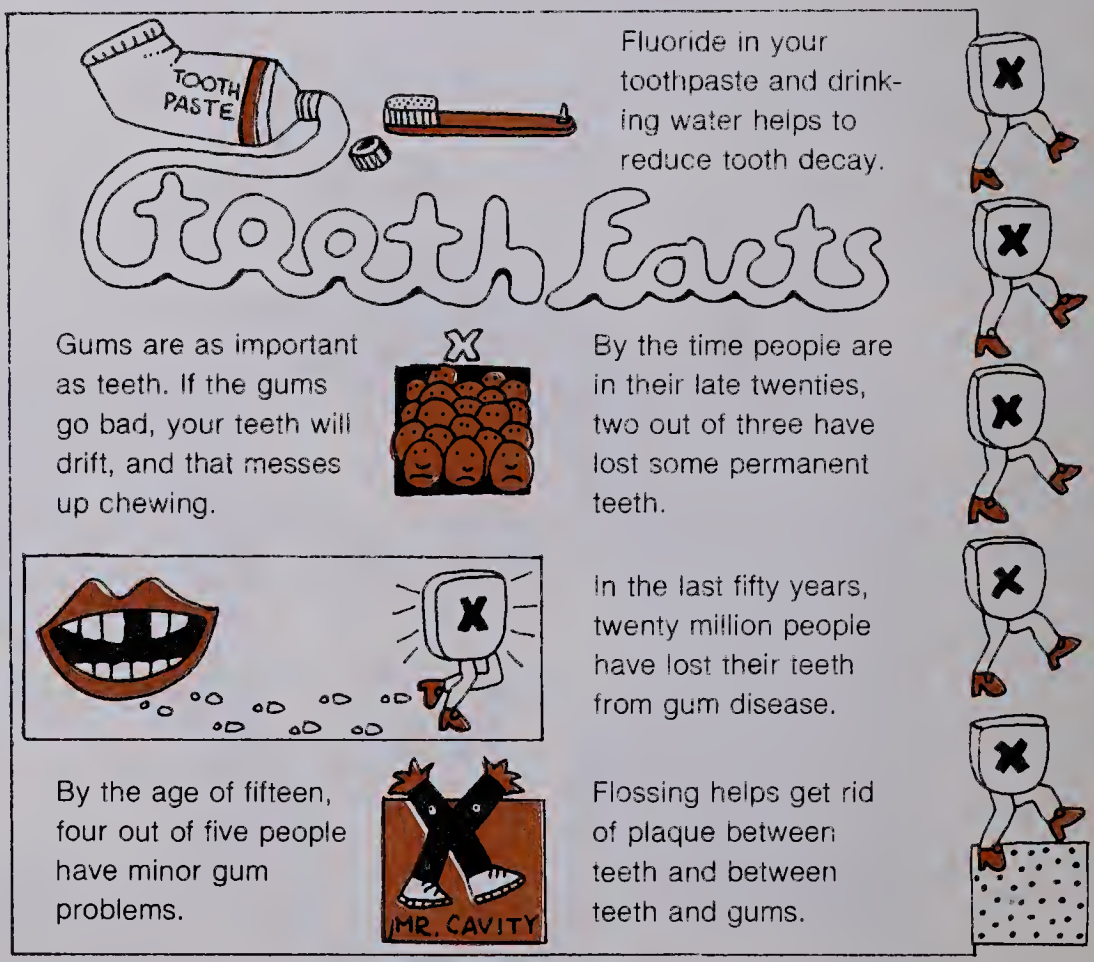
★ **13–5. Does brushing help get rid of plaque? Where does brushing do the best job?**

Because it is difficult to brush between your teeth, plaque builds up there. Dental floss is helpful for getting at that hard-to-reach plaque. If you haven't been shown how to use dental floss properly, ask your dentist to show you. It's important to floss every day.

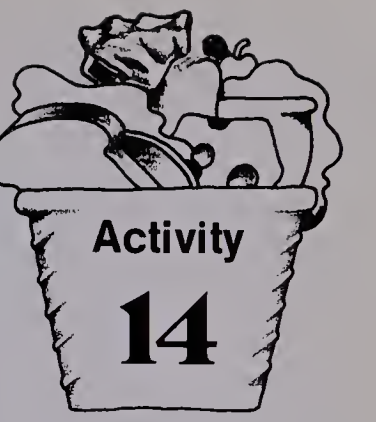
★ **13–6. Where does flossing do the best job in getting rid of plaque?**

When plaque is allowed to remain on teeth, it hardens and attaches itself firmly to the teeth. Hardened plaque is called *tartar*. When tartar builds up around the gum line, it can cause the gums to get red, swell, and feel hot. If you let that condition go on too long, you might lose your teeth to gum disease.

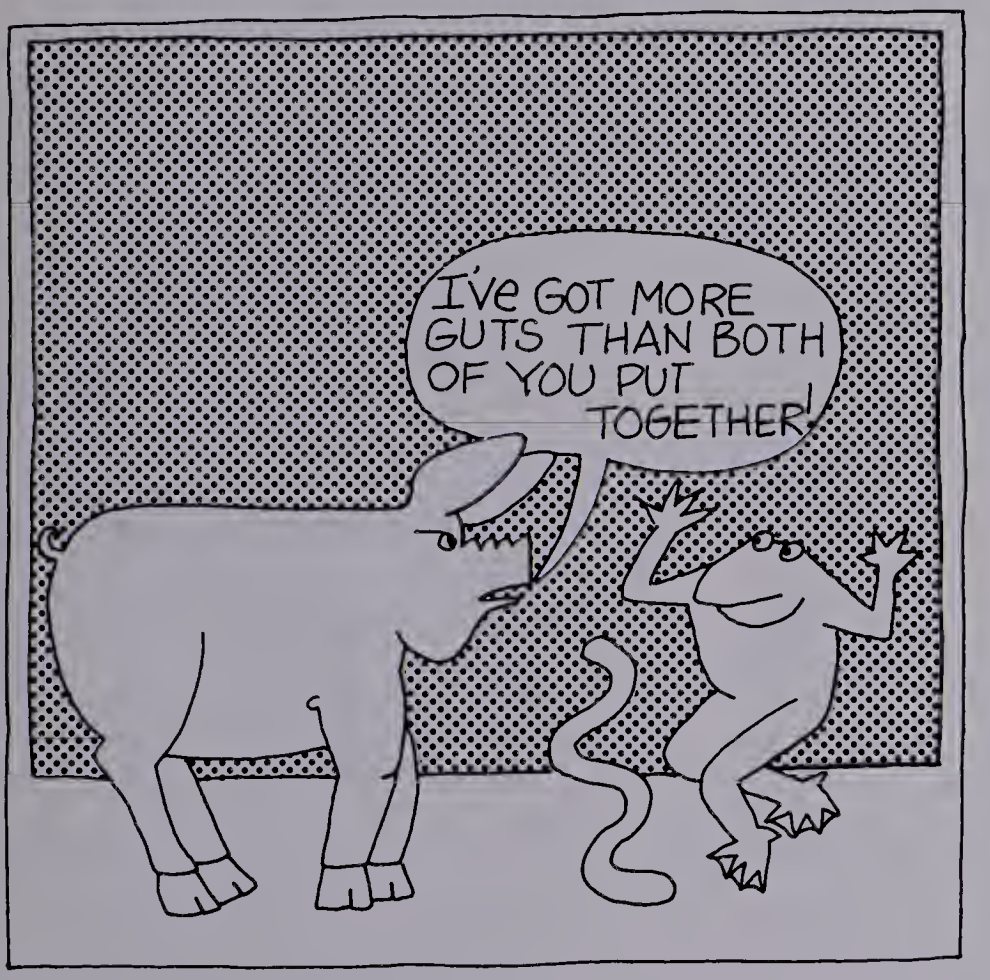
★ **13–7. What stuff in your mouth is responsible for cavities and gum disease?**



Comparing Guts



In this activity, you will look at the digestive systems of several organisms and compare them with what you know about your own. You should allow about two days for this activity.



To see how other digestive systems are similar and different from your own, you will need a dissection probe, a hand lens, and at least *one* of the following:

dissected earthworm attached to a pan
dissected crayfish attached to a pan
dissected frog attached to a pan
dissected fetal pig attached to a pan

Before beginning, copy the chart in Figure 14–1 into your notebook.

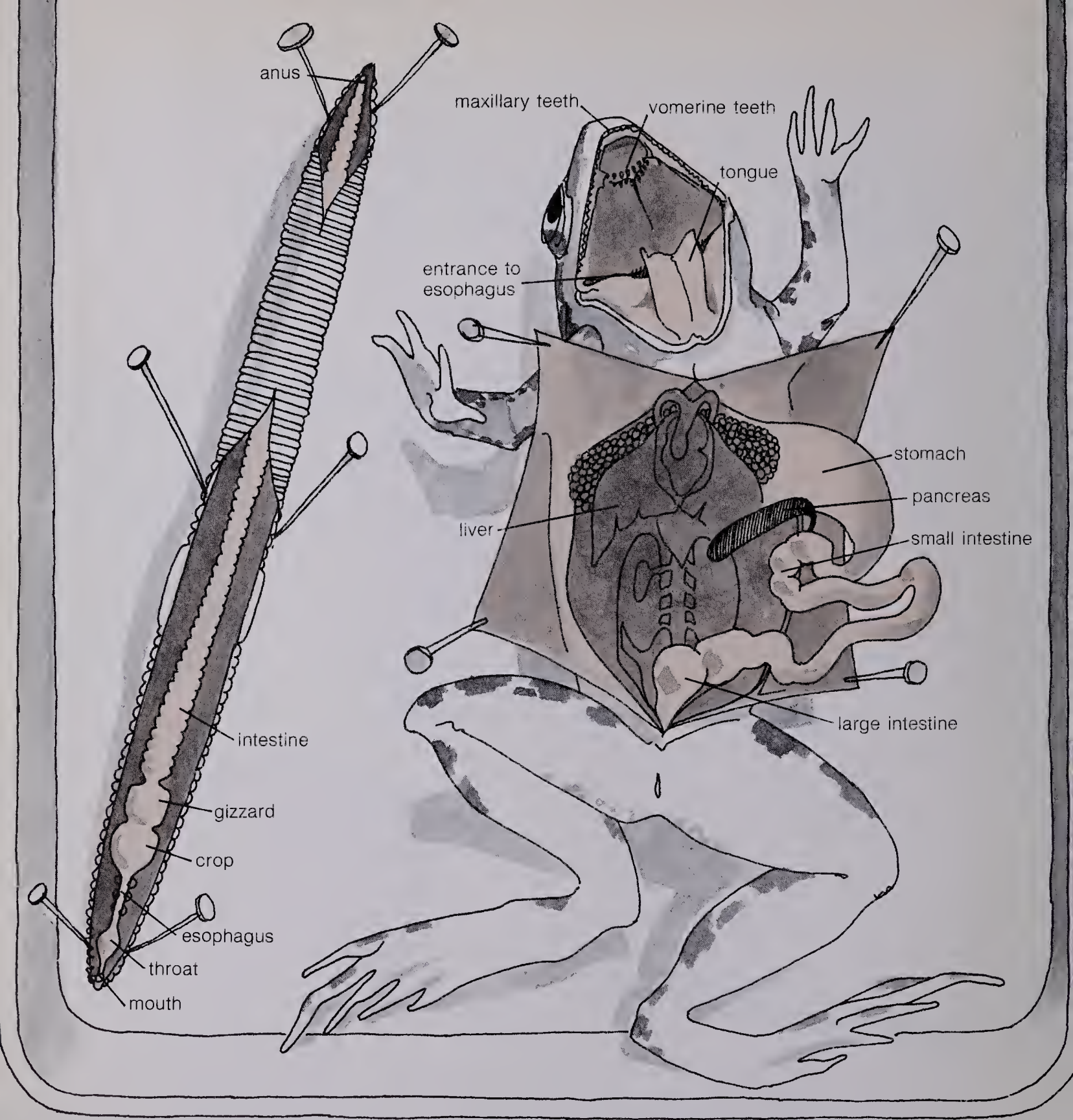
DIGESTIVE SYSTEMS

PARTS	EARTHWORM	CRAYFISH	FROG	FETAL PIG	HUMAN
Mouth opening					
Lips					
Teeth					
Tongue					
Esophagus					
Stomach					
Folds inside stomach					
Small intestine					
Folds inside small intestine					
Pancreas					
Liver					
Gall bladder					
Large intestine					
Rectum					
Anal opening					

Figure 14–1

Get one of the dissected specimens. Try to locate each of the parts of the gut listed in the chart. As you find a part, check it off in the chart.

Repeat the procedure for each of the remaining dissected specimens. The specimens should look similar to those shown in this activity. For any specimen you can't get, use an illustration. For the column titled "Human," you may want to review Activity 2 before checking off the parts.

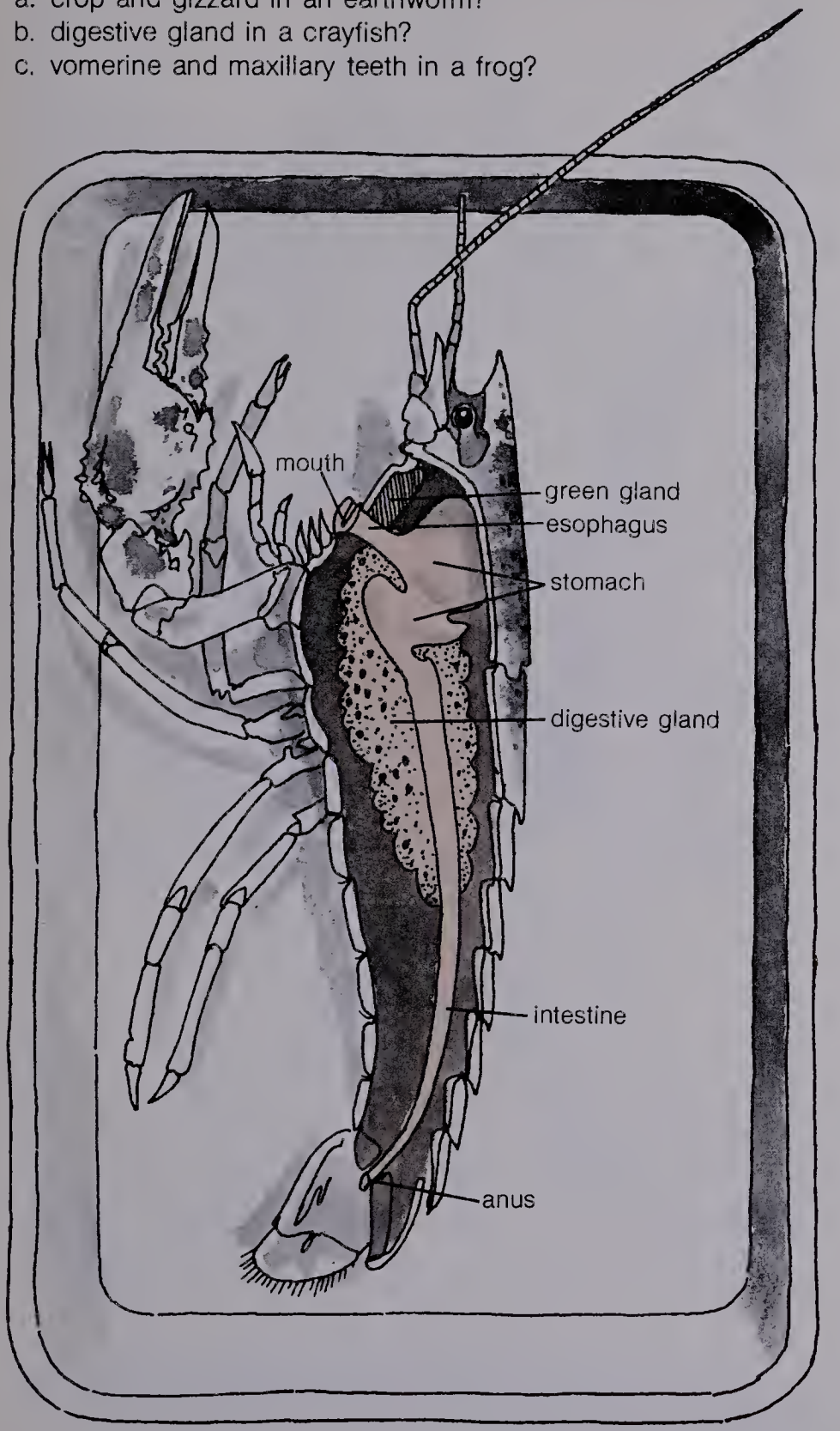


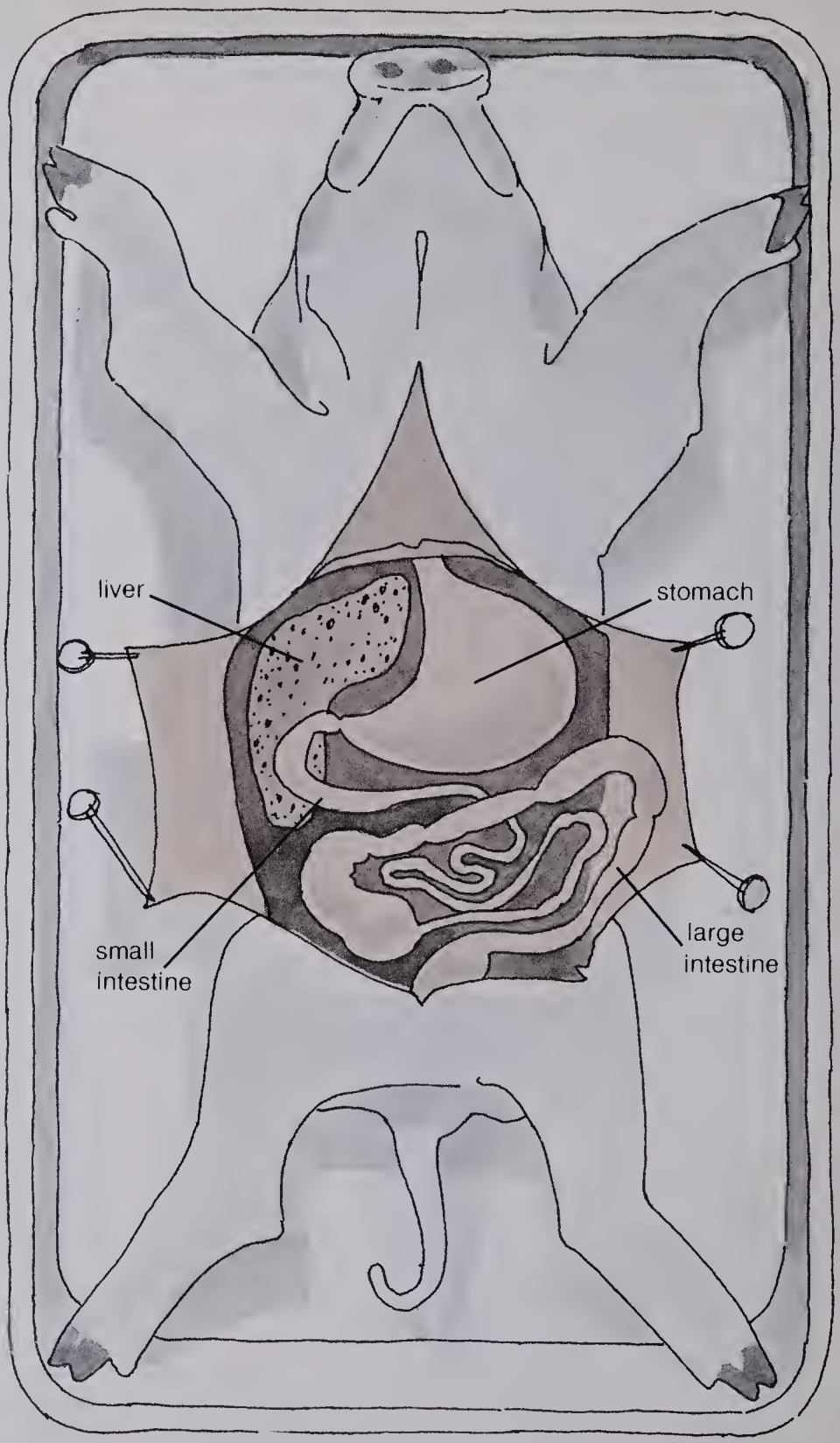
✔ 14–1. Which specimen has a gut most unlike your own? What makes you think so?

✔ 14–2. Which specimen has a gut most like your own? What makes you think so?

✔ 14–3. Which of your digestive parts is similar in function to the

a. crop and gizzard in an earthworm?
b. digestive gland in a crayfish?
c. vomerine and maxillary teeth in a frog?





★ **14–4. Choose an earthworm, or a crayfish, and describe three similarities and three differences between the gut of that animal and your own.**

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